State of Louisiana

The Honorable Kathleen Babineaux Blanco, Governor

Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast

CPRA

Coastal Protection and Restoration Authority of Louisiana


LOUISIANA
JUSTICE
CONFIDENCE

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April 30, 2007

Dear Members of the Louisiana Legislature,

I am proud to submit for your consideration and approval, the state's coastal master plan, entitled Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast. The completion of this plan is an historic step in a journey which promises safer communities, a more sustainable coastal landscape, and a brighter future for Louisiana.

Based on years of coastal research and on lessons learned after the hurricanes of 2005, this Master Plan represents a bold vision for the complete integration of coastal protection and restoration. For the first time in Louisiana's history, state and local governments will be truly focused on the comprehensive, long term protection of our coastal communities and the sustainable restoration of our coastal landscape, working closely with the Congress to ensure a high level of federal coordination and support.

Over the past eighteen months, the Coastal Protection and Restoration Authority marshaled, through its integrated planning team, the best expertise available in developing this Master Plan. During almost five months of public review of the plan, they engaged members of the Louisiana Legislature, local governments, critical state and national stakeholders, and key leaders in the Congress and the federal Executive Branch of government. This plan embodies an open and credible process that will continue as it is implemented and adapted, using the best science and engineering here and throughout the world.

The death and devastation caused by hurricanes Rita and Katrina have strengthened our resolve to establish a lasting legacy of coastal protection and restoration for south Louisiana. The passage of this Master Plan is the first step in making that legacy a reality for our coastal communities today.

Sincerely,

Kathleen Babineaux Blanco

Kathleen Babineaux Blanco
Governor

Coastal Protection and Restoration Authority Members

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The Authority recognizes the contributions of Year 2006 members who contributed their time and effort to this critical effort:

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Executive Summary

Setting the Bar Higher

The Master Plan was developed to fulfill the mandates of Act 8, which was passed by the Louisiana Legislature in November 2005 and signed into law by Governor Blanco. The act created the Coastal Protection and Restoration Authority (CPRA) and charged it with coordinating the efforts of local, state, and federal agencies to achieve long-term and comprehensive coastal protection and restoration. In so doing, the CPRA must integrate what had previously been discrete areas of activity: flood control and wetland restoration. Act 8 also requires that the CPRA establish a clear set of priorities for making comprehensive coastal protection a reality in Louisiana.

The Master Plan is the principal means for achieving this goal. As such, the plan is informing several ongoing efforts, including the Louisiana Recovery Authority's Louisiana Speaks planning process and the development of the U.S. Army Corps of Engineers' Louisiana Coastal Protection and Restoration Report, which will be completed in December 2007.

The Master Plan presents a series of recommended hurricane protection and coastal restoration measures. Maps and explanations about the measures, as well as a management strategy for implementing them are also provided. Taken together, the Master Plan presents a conceptual vision of a sustainable coast based on the best available science and engineering.

The need for this comprehensive, integrated approach is acute. Since the 1930s, coastal Louisiana has lost over 1.2 million acres and is still losing land at the rate of 15,300 acres per year. This extreme rate of loss threatens a range of key national assets and locally important communities. Pipelines, navigation channels, and fisheries as well as centuries-old human settlements and priceless ecosystems are all at risk.

Hurricanes Katrina and Rita intensified the problem. Approximately 200 square miles of marsh were destroyed, over 200,000 homes were damaged, over 1,400 Louisianians died, and more than one million state residents were displaced by the storms. The hurricanes also disrupted the national economy, spiking fuel prices, lowering energy reserves, and slowing grain shipments to world markets. The hurricanes' effects highlighted the need to improve Louisiana's hurricane protection systems and restore the wetlands upon which so much of our national economy depends.

Goals of the Master Plan

- **Present a conceptual vision for a sustainable coast.**
- **Be a living document that changes over time as our understanding of the landscape improves and technical advances are made.**
- **Emphasize sustainability of ecosystems, flood protection, and communities.**
- **Integrate flood control projects and coastal restoration initiatives to help both human and natural communities thrive over the long-term.**
- **Be clear about what we don't know. In some areas, scientific and technical advancements will be needed before we can make definitive pronouncements as to what will happen.**

What Coastal Louisiana Provides

- **Energy infrastructure:** The wetlands protect critical oil and gas infrastructure from storm surge. This infrastructure produces or transports nearly one-third of the nation's oil and gas supply, and is tied to 50% of the nation's refining capacity (LA Department of Natural Resources, 2006).

- **Shipping:** Ten major navigation routes are located in south Louisiana. Five of the busiest ports in the U.S., ranked by total tons, are also located here. These facilities handle 19% of annual U.S. waterborne commerce (USACE, 2003).

- **Fisheries and wildlife habitat:** Louisiana provides 26% (by weight) of the commercial fish landings in the lower 48 states (US Department of Commerce, 2005). More than five million migratory waterfowl spend the winter in Louisiana's marshes (LA Department of Wildlife & Fisheries, 2000). The coastal landscape also provides stopover habitat for millions of neotropical migratory birds and 17 threatened or endangered species.

- **Water quality:** If river water flows through them, wetlands can filter nutrients that would otherwise flow directly into the Gulf of Mexico. Concentrations of these nutrients in the northern Gulf of Mexico contribute to the growing problem of hypoxia, or low oxygen conditions, in offshore coastal waters.

- **Culture:** The diverse peoples of south Louisiana have created a multi-faceted culture known throughout the world. Moreover, coastal Louisiana is home to two million residents, or over half of the state's population.

Assumptions and Technical Challenges

The planning team used several assumptions to guide their work.

1. This version of the Master Plan is a first cut at what will be a living document that changes over time.
2. A sustainable landscape is a prerequisite for both storm protection and ecological restoration.
3. Change is inevitable; the ecosystem is degrading now, and restoring sustainability will bring changes of its own.
4. Plans for hurricane protection must rely on multiple lines of defense.

Such assumptions lead to difficult choices, and the Master Plan enumerates several tradeoffs implicit in its proposals. For example, not every community will receive the same level of hurricane protection. The plan also discusses the shifts in fisheries and other traditional uses of the coast that are likely to occur when major river diversion projects are constructed.

Technical unknowns pose challenges as well. Questions remain about the ways in which climate change will affect the coast, as well as how to best balance the effects of diversions, levees, and restoring marshes using dredged sediments. Although we do not yet have all the answers, we do know that many of our existing protection and restoration techniques are effective.

We must begin creating a sustainable coast without delay, using methods that we know can work, while also field testing new concepts and learning as we go. Given the magnitude of the task at hand, a stepwise process based on sound science and engineering is the only way forward.

The Master Plan

An Integrated Planning Team made up of employees from the Department of Natural Resources and the Department of Transportation and Development took the lead in developing the Master Plan. The team, working in consultation with stakeholders, scientists, engineers, and the public, identified four objectives that define what the plan seeks to achieve:

- reduce risk to economic assets
- restore sustainability to the coastal ecosystem
- maintain a diverse array of habitats for fish and wildlife
- sustain Louisiana's unique heritage and culture

The full text of the objectives, as well as principles that guided the group's work, are presented in Appendix A.

Timeline: How the Master Plan was Developed

Act 8 Signed	Nov. 2005
Integrated Planning Team established	Feb. 2006
First plan formulation workshops held	May 2006
Plan formulation report completed	June 2006
Plan formulation report included in USACE report to Congress	July 2006
Six LA Recovery Authority Louisiana Speaks workshops held, providing input to Master Plan process	July-Aug. 2006
Over 50 stakeholder workshops and meetings held	July-Nov. 2006
Decision process workshop held with agency partners, science advisors, and NGOs	Sept. 2006
Second plan formulation workshops held	Oct. 2006
Preliminary Draft Master Plan presented for public review; 9 public meetings held	Nov.-Dec. 2006
Technical review panels meet and offer comments on Preliminary Draft Plan	Dec. 2006-Jan. 2007
Draft Master Plan presented for public review; 3 public hearings and 1 public meeting held	Feb.-March 2007
Technical review panels meet and offer comments on Draft Master Plan	March 2007
Final Master Plan submitted to legislature	April 2007

The measures contained in the plan can be broken down into three groups, based upon the broad outcomes they deliver:

- Restoring sustainability to the Mississippi River Delta
- Restoring sustainability to the Atchafalaya River Delta and Chenier Plain
- Hurricane protection—both structural and non-structural measures

Restoring Sustainability to the Mississippi River Delta

Creating a sustainable deltaic system requires that we reestablish the processes that originally created the landscape.

Reconnecting the Mississippi River to the wetlands through controlled diversions will restore flows of water through the wetlands so that the ecosystem can retain sediment and nutrients. We also need to act quickly to restore critical landforms before they are lost.

Land building diversions. Commonly referred to as the Mississippi River Delta Management plan, this concept involves building very large diversions that will use the majority of the river's sediment and fresh water to both create new delta lobes and nourish existing wetlands. We do not yet know where, how big, or how numerous these diversions will be, but some possible scenarios are presented in Figures 7 and 8. As this concept is studied further, we must consider not only how to sustain new wetlands but also how navigation and natural resource interests will be affected.

Land sustaining diversions. These diversions are not designed to build wetlands in large areas of open water, rather they are designed to reduce loss and restore the sustainability of existing wetlands. The proposed diversions are envisioned as parts of an interconnected system that will be operated as a whole; individual projects will not be operated in isolation. Along these lines, it is important to review the operation of Davis Pond, Caernarvon, and other land sustaining diversions already in place to ensure that these diversions are providing maximal ecosystem restoration benefits.

Marsh restoration with dredged material. Diversions distribute sediments to areas of need, rather than allowing the sediments to be channeled out of the coastal ecosystem into offshore waters. Another important tool for "getting the sediment right" is distributing these lost sediments through dredging and pipeline conveyance to restore wetlands. One way to

accelerate the benefits of diversions would be to mechanically restore lost marsh by pumping sediments via pipeline from the bed of the Mississippi River, offshore, or from navigation channels.

Navigation channels. The plan recommends using existing navigation channels, such as the Gulf Intracoastal Waterway and the Houma Navigation Canal, as "new distributaries" that could channel water to more remote areas of the coast.

Barrier shoreline restoration. Barrier shorelines are important habitat for many bird species as well as threatened and endangered animal species. They also serve as a first line of defense against storm surge. Barrier shoreline restoration is recommended in the Terrebonne and Barataria Basins because these ecologically important habitats are close enough to marsh and human settlements to diffuse wave energy and storm surge. In the Chandeleur Islands, the state will work with the Department of the Interior as it continues to develop a restoration and management plan to maintain the area as a national wildlife refuge.

Ridge habitat restoration. Ridges are natural elevated features that support woody vegetation and provide habitat for a variety of wildlife species, including migratory species crossing the Gulf. These features can also deflect storm surge, particularly during lower energy winter and tropical storms.

Shoreline stabilization. The plan recommends stabilizing selected shorelines near critical land masses as well as marsh fringes near flood protection works. This can be accomplished either by rock structures or by establishing living reefs. Securing shorelines will help preserve the boundaries of waterbodies and protect areas such as the Biloxi Marshes, the bay side of Grand Isle, and the Jefferson Parish levee system.

Closure of the Mississippi River Gulf Outlet. The plan calls for the immediate closure of the MRGO to deep draft navigation and for the construction of a closure dam at Bayou LaLoutre. The plan's intent is to restore the integrity of the Bayou LaLoutre ridge and use the remainder of the channel to convey fresh water from the Mississippi River to the Biloxi Marshes and other areas of St. Bernard Parish. The plan also includes restoration of wetlands and swamps in the Central Wetlands and Golden Triangle areas. Since this strategy will affect deep and shallow draft navigation industries, appropriate economic mitigation plans will be needed after the channel is closed. In this regard, the status of the Inner Harbor Navigation Canal lock must be resolved.

Restoring Sustainability to the Atchafalaya River Delta and Chenier Plain

The Atchafalaya River Delta is the only region of coastal Louisiana that is building land naturally, and the Master Plan seeks to take maximum advantage of this resource. Further west in the Chenier Plain, navigation channels and canals have allowed salt water to penetrate inland, destroying fragile marsh and impinging on freshwater lakes. The Chenier Plain Freshwater and Sediment Management and Reallocation Plan, recommended in the Master Plan, will help fine tune appropriate measures for the region.

Managing water and sediment. In order to reduce the impacts of periodic saltwater intrusion, the plan suggests managing river and surface fresh water supplies to ensure the availability of fresh water throughout the year. Such management will also permit the delivery of fresh water to areas that may be exposed to saltwater stress while also reducing reliance on groundwater resources.

- Navigation channels provide opportunities to distribute fresh water from the Atchafalaya River. For example, the GIWW could be used as a conduit to move the river's water to the west.

- The plan recommends that drainage be wisely managed in the Mermentau Basin. Such management would ensure that fresh water is available where needed for ecosystem and agriculture needs, but that communities are not placed at greater risk of flooding.

- The plan seeks to maintain the integrity of freshwater resources by shoring up the banks of selected navigation channels, fortifying and maintaining spoil banks along the GIWW and Freshwater Bayou Canal, raising and armoring critical sections of highways, and placing saltwater barriers at deep draft shipping channels to manage salinity levels.

Marsh restoration using dredged material. New land can be created by using dredged material from maintenance dredging of navigation channels. This is a particularly viable strategy in areas near the Calcasieu Ship Channel and the Atchafalaya River Navigation Channel. In other areas, material dredged and transported from offshore could be used to restore lost marsh.

Barrier shoreline restoration. Restoring the barrier shorelines of the Chenier Plain in areas of severe shoreline retreat will be accomplished using a combination of two methods: sand; placement and use of hard structures, such as offshore segmented breakwaters. These methods will help ensure that the shoreline maintains its integrity and protects interior marshes while continuing to allow tidal exchange.

Levees, or some other form of flood control structure, are recommended for high risk areas that must be protected in order to avoid severe consequences for the state and nation.

Lake shoreline stabilization. The plan recommends stabilizing key areas along the Chenier Plain's bay and lake shorelines that, if breached, would have catastrophic results for the landscape. By preventing lakes from growing in size, stabilization will also protect surrounding marsh, cheniers, and coastal prairie from wave induced erosion.

Hurricane Protection

If the state and nation are to continue enjoying the benefits provided by the communities of south Louisiana, new and upgraded hurricane protection systems are necessary. The level of protection provided will be proportional to the assets at risk. There is concern that levees built across swamp and marsh would stop the flow of water, leading to further wetland loss and creating impoundments that flood communities. These concerns must be addressed as projects are developed.

Consider the entire system. Water, sediment and nutrients must be delivered to the wetlands, and overall hydrology must be improved by minimizing impediments to water flow. Protection and restoration actions must be designed to work together to ensure that they do not induce flooding in low-lying communities, and that flood water is not trapped within the system.

Hurricane protection structures must be built and maintained so that the ecosystem remains dynamic and functional.

Use non-structural measures to reduce risk. Given that levees and restored wetlands cannot eliminate all damage from flooding and storms, non-structural solutions offer tools that communities can use now to reduce their risks. In this regard, keeping wet areas wet is important, both for safety and flood control reasons. Approved evacuation plans must be followed, and evacuation routes must be properly maintained and armored as necessary. Communities must also follow FEMA-approved hazard mitigation plans and consider compartmentalization plans.

Non-Structural Solutions: Tools Citizens Can Use

- **Flood insurance**. Because of its low lying topography, Louisiana has the highest rate of repetitive flood losses in the nation. Given the base risk, all residents of coastal Louisiana should purchase flood insurance.

- **Elevating and retrofitting structures.** Residents of south Louisiana can improve their homes in ways that reduce the risk of storm damage. Hazard mitigation funds are available to citizens for this purpose.

- **Building codes.** The 2007 Louisiana State Uniform Construction Code is designed to ensure that new construction can better withstand hurricane force winds. Citizens must comply with the provisions of this code.

Focused structural solutions. Restoration and non-structural measures can reduce the risk from storm surge. But in most areas of coastal Louisiana, the number of people and assets at risk warrants higher degrees of protection. The Master Plan recommends building hurricane protection systems in the following areas.

- *Lake Pontchartrain Barrier Plan.* To increase protection in metro New Orleans, including areas such as the North Shore of Lake Pontchartrain that have no protection today, an outer barrier must be built. This barrier should raise protection over the level needed to withstand a storm that has a 1% chance of occurring in

any given year. Figures 13-15 show some concepts being considered for this project, but additional planning and design is needed in order to select the appropriate alignment.

- *Barataria Basin and West Bank.* Additional hurricane protection structures must be built to increase protection to the West Bank of metro New Orleans and to provide protection to central and western Barataria Basin communities that have no protection today. The upgraded hurricane protection system would work with projects already underway to provide the West Bank with protection over the level needed to withstand a storm that has a 1% chance of occurring in any given year. In addition, the project would provide protection to Lafourche Parish and the communities in the central Barataria Basin sufficient to withstand a storm with a 1% chance of occurring in any given year.

  The state is awaiting the results of further modeling to refine alternative alignments for this project (see Figures 16-18 for some possibilities now under consideration). In addition, new engineering options are needed in order to design flood control structures that will work in conjunction with diversions north of the alignment. Together, these structures should be planned and designed to maximize sustainability while providing needed hurricane protection. All of these issues will be explored in depth as feasibility studies for the project are conducted.

- *Plaquemines Parish.* The plan recommends a multi-faceted protection plan for Plaquemines Parish. All sections of levees intended to provide hurricane protection would become federal levees under this plan. Levees south to Oakville would be raised to provide a greater than 100 year level of protection, meaning protection over the level needed to withstand a storm that has a 1% chance of occurring in any given year. Levees between Oakville and Myrtle Grove on the west bank and between Caernarvon and White Ditch on the east bank would be improved to improve to withstand a storm that has a 1% chance of occurring in any given year. As stated above, these stretches of levees would be made part of the federal hurricane protection system.

The drainage levee south of Myrtle Grove would also be federalized and brought to the same elevation as the current federal hurricane protection levees in southern Plaquemines Parish. South of St. Jude on the west bank and south of Phoenix on the east bank, the levees would be maintained at their currently authorized heights. This plan would protect concentrations of industry and populations, while respecting the limitations imposed by the unique geography of Plaquemines Parish.

- *Terrebonne Parish and Atchafalaya Delta.* The plan recommends construction of the existing alignment for the Morganza to the Gulf project, which has been approved after more than 15 years of study by citizens, scientists, and federal agencies. The project will protect the Houma/Thibodaux area, which has a growing population of over 200,000 residents and is currently unprotected. An inner barrier to provide a second line of defense south of Houma may also be needed, pending further study. Regardless, the Morganza to the Gulf project must proceed without delay.

- *LA 1 Highway Corridor.* Louisiana's southernmost port is Port Fourchon, strategically located in the central Gulf region where it serves as a focal point for deepwater oil and gas activities. However, the only roadway connecting the port to the rest of the nation is the vulnerable, two-lane LA 1 highway. Efforts are underway to upgrade and raise on concrete structure the sections of LA 1 that are outside of the existing levee system. To protect the portion of this federally recognized energy corridor that lies within the levee system, the levee between LaRose and Golden Meadow should be raised significantly to provide a 1% level of protection. This means that the protection would be sufficient to withstand a storm with a 1% chance of occurring in any given year. Completion of the Morganza to the Gulf and Donaldsonville to the Gulf projects, together with restoration activities, would further increase levels of protection to this highway. If ongoing modeling and analysis show that risks to assets in this area remain unacceptably high, the Master Plan recommendations will be modified accordingly.

- *Acadiana.* In this region, the highest concentrations of assets are found in Lafayette, New Iberia, and Abbeville. The plan recommends that these areas receive a greater than 100 year level of protection, meaning protection over the level needed to withstand a storm that has a 1% chance of occurring in any given year. Areas between New Iberia and Berwick/Patterson should be protected to withstand a storm with a 1% chance of occurring in any given year. However, much planning and analysis remain to be done before deciding how best to protect this region.

- *Chenier Plain.* The plan recommends that the Lake Charles/ Sulphur area receive a greater than 100 year level of protection. This may be achieved with a ring levee that surrounds population centers as well as critical oil and gas infrastructure. Much planning and analysis remain to be done before deciding how best to protect this region.

  Areas between Abbeville and Lake Charles, where the human population is large but dispersed, would initially be protected by fortifying spoil banks and raising highways in critical locations. If the highway is located on or at the base of a chenier, raising it further is likely unnecessary. The plan recommends improving protection to homes and properties located on cheniers by armoring highway embankments in certain vulnerable locations. In selected low spots, such as along the eastern edge of Highway 82 south of Forked Island, the highway will need to be raised in order to protect the Mermentau Freshwater Basin. If further analysis shows that these measures will not provide enough protection, a levee would be considered along the GIWW. This analysis is ongoing.

Next Steps: Implementing the Master Plan

Some of the measures described above must be implemented before others for a variety of reasons, including: funding constraints, institutional barriers, technical unknowns, and the requirements of individual projects. The state's *Annual Plan: Ecosystem Restoration and Hurricane Protection in Coastal Louisiana* will be the vehicle for presenting yearly scheduling and cost information about projects. The Annual Plan will also offer yearly updates on progress, strategies, technical challenges, and priorities.

An adaptive management strategy underlies every aspect of what the program will accomplish in the coming years. This strategy uses a science and performance based process for assessing how the plan and its projects need to change over time so that the best available practices are consistently used. The use of adaptive management also presupposes strong engagement from citizens and other affected constituencies. Such engagement involves enhanced dialogue with a range of stakeholders, including landowners, fishers, and the navigation community, as well as scientific, engineering, and other technical experts.

We must also resolve important challenges, from scientific and technical uncertainties to institutional constraints. For example, we need better models so that we may better assess how to balance the many interests involved as we build flood protection systems, create marsh, and use multiple river diversions in the same estuarine basin. Changes in laws and policies are also needed to ensure successful implementation of the plan.

Plan Recommendations for Removing Institutional Constraints

- **Increase awareness and use of non-structural protection measures**
- **Improve land use planning, zoning, and permitting**
- **Develop fair and equitable processes for acquiring surface land rights**
- **Foster the sustainability of coastal forests**
- **Obtain dedicated funding for coastal protection and restoration**
- **Address challenges at the federal level**

We are living in a historic moment, one that presents us with a stark choice: either make the bold and difficult decisions that will preserve our state's future, or cling to the status quo and allow coastal Louisiana and its communities to wash away before our eyes.

As the coastal program moves ahead, the plan recommends that a Coastal Assessment Group be made part of the state's management structure, along with an Applied Coastal Engineering and Science Program. These groups would be responsible for making sure that advancements in science and technology are integrated into the state's program.

Stringent inspections of hurricane protection systems, assessments of the effects of restoration and protection actions, and regular updates of the Master Plan are also important tools for keeping the program on track.

These recommendations assume as their point of departure that saving coastal Louisiana and the critical services it provides requires the same basic commitment from all concerned: the resolve to achieve and maintain an unprecedented level of excellence in our stewardship of coastal Louisiana. This commitment does not seek to elevate one set of needs over another, but rather to balance the many interests—cultural, economic, and ecological—that together make America's Wetland one of the most unique and vital coastal regions in the world.

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Preface: A New Resolve

Act 8 Sets the Bar Higher

What had been a crisis has now turned into a bona fide emergency: extreme rates of land loss compounded with inadequate hurricane protection measures threaten the viability of south Louisiana's communities and infrastructure. Scientists, engineers and policy makers have long worked to improve wetland restoration and hurricane protection in the region, even as the wetlands converted to water at a rapid rate. However, Hurricanes Katrina and Rita intensified these urgent needs. Not only did the storms destroy huge swaths of wetlands outright, but the resulting destruction and human misery revealed the inadequacy of the state's hurricane protection systems. Over 1,400 Louisiana residents died, 200,000 homes sustained major damage, and approximately 440,000 Louisiana citizens were still displaced from their homes one year after the storms.

To correct the root causes of these problems, Louisiana is accelerating efforts to create a sustainable coast. As Hurricanes Katrina and Rita made clear, we cannot meet this goal unless we return the wetlands to health, change the way we manage and live in this dynamic landscape, and improve our hurricane protection systems. Furthermore, we have learned that levees and wetland restoration projects can no longer be constructed in separate spheres. Instead, flood control and wetland restoration projects must be designed, built, and operated in coordination, taking into account how individual projects interact with each other. Recognizing the importance of this integrated strategy, the state enacted legislation to coordinate what had been discrete areas of activity: hurricane protection and coastal restoration.

The vehicle for articulating these policy changes was Senate Bill 71, which was adopted by the Louisiana Legislature during the First Extraordinary Session in


ENROLLED

First Extraordinary Session, 2005 ACT No. 8

SENATE BILL NO. 71 (Duplicate of House Bill No. 141)

BY SENATOR DUPRE AND REPRESENTATIVE ALARIO AND COAUTHORED BY SENATORS AMEDEE, BAJOIE, CAIN, CHAISSON, CHEEK, B. GAUTREAUX, N. GAUTREAUX, FONTENOT, HOLLIS, JONES, LENTINI, MOUNT, MURRAY,

November 2005 and signed by Governor Blanco as Act 8. This legislation created the Coastal Protection and Restoration Authority (CPRA) and charged it with coordinating the efforts of local, state, and federal agencies to achieve long-term, comprehensive coastal restoration and hurricane protection. One of the central tenets of this legislation is that state agencies must move beyond jurisdictional boundaries and ensure ongoing integration of hurricane protection and coastal wetland restoration activities. Act 8 seeks to integrate hurricane protection and coastal restoration activities to provide for a safe and sustainable Louisiana.

Act 8 directs the CPRA to supply "aggressive state leadership and direction" as new policies, plans, and programs for the coast are developed. Emphasizing coordination in this way and giving the CPRA the power to enforce it are both groundbreaking aspects of Act 8. In addition, the act requires that the CPRA use its leverage to resolve conflicts in the fine print—those policy, institutional, and legislative constraints that, if not dealt with, could hamstring effective action.

The Master Plan

Act 8 stipulates that the CPRA establish a clear set of priorities for making comprehensive coastal restoration and protection a reality in Louisiana. To this end, the act charged the CPRA with developing a Master Plan that presents a conceptual vision of a sustainable coast based on the best available science and engineering.

The Master Plan takes a comprehensive view as it describes which actions will sustain Louisiana's coastal ecosystem, safeguard coastal populations,

Courtesy Scott Russell Photography

City of New Orleans from St. Bernard Parish marshes.

and protect vital economic and cultural resources. In the past, individual programs and projects may have been carried out for single purposes that did not relate to a larger vision. The Master Plan, by contrast, provides a vehicle for focusing funding and projects toward a common goal. The state will use new programs as well as existing programs such as the Coastal Wetlands Planning, Protection and Restoration Act Program (CWPPRA), the Louisiana Coastal Area Program (LCA), and the Coastal Impact Assistance Program (CIAP) to implement the Master Plan. In addition to shaping how restoration and protection funds are spent, the Master Plan provides a context within which to evaluate other activities in the coastal zone, including: transportation, navigation, and port projects; oil and gas development; groundwater management; and land use planning.

Recognizing that the Master Plan will play a critical role in Louisiana's future, the plan's development has been closely coordinated with other related efforts. The Louisiana Recovery Authority has used iterations of the Master Plan as it considered redevelopment options for south Louisiana through its Louisiana Speaks Initiative, a planning process that will guide the region's recovery and long-term growth. The U.S. Congress has directed the U.S. Army Corps of Engineers (Corps) to develop its own Louisiana Coastal Protection and Restoration (LACPR) report by December 2007. While the Corps's plan does not deal with many of the policy and legislative issues contained in the Master Plan, the state and the Corps are working to ensure that both plans are congruent and complementary.

The Master Plan was drafted by an Integrated Planning Team (IPT) made up of senior staff from the Department of Natural Resources (DNR) and the Department of Transportation and Development (DOTD). The Corps of Engineers New Orleans District also assigned a senior staff person to serve as a liaison to the team. The IPT members were chosen because their diverse backgrounds and multiple areas of expertise help address the many economic, cultural, and technical issues that must be woven into the plan. This planning effort was supported by a multi-disciplinary consultant team including Shaw Coastal; Brown, Cunningham and Gannuch, Inc.; and Halcrow, Inc. After the plan has been approved by the Legislature, Act 8 stipulates that DNR has responsibility for implementing projects related to coastal wetlands, and DOTD has responsibility for implementing projects related to hurricane protection.

This document describes why the coast must be protected and restored, discusses the underlying rationales behind the Master Plan, provides maps and explanations about what the plan contains, and outlines a long-term management strategy for implementation. More details about the information discussed in this report can be found in technical appendices, available at www.louisianacoastalplanning.org.

The plan could not have been created without the thousands of coastal residents, stakeholders, scientists, and engineers who provided ideas and in-depth comments at each stage of the plan's development. The planning team sincerely thanks these contributors for their involvement. Appendices C-1 and C-2 offer copies of the 2,000 pages of public comments and notes received from December 2006 to March 2007. Appendices B and H present stakeholder comments received as part of early plan formulation workshops.

Flock of roseate spoonbills in South Louisiana wetlands.

What America's Wetland Provides

Because it supplies so many benefits to the nation, south Louisiana's coast is known as "America's Wetland."

STORM PROTECTION

Wetlands and barrier islands reduce storm surge for inland communities and protect critical shipping and energy infrastructure.

FISHERIES AND HABITAT

The coast provides shelter and spawning grounds for thousands of fish and wildlife species.

CULTURE

The coast is home to unique human communities.

Chapter 1: What Is At Stake?

America's Wetland—A Working Coast

South Louisiana encompasses internationally significant ecosystems, culturally unique communities, nationally significant fisheries, and world centers of shipping and industry. Though renowned for its beauty and natural resources, the landscape is not a wilderness. The homes and businesses of half of Louisiana's citizens, along with major ports and industrial facilities, are all located within this one of a kind region.

Louisiana's coastal landscape provides a host of benefits, including protection from flooding. Barrier islands, healthy marshes, natural ridges adjacent to bayous, and cypress swamps provide a natural buffer during storms by slowing down and reducing incoming surges of water. This function, combined with man-made levees and other flood control measures, have allowed Louisiana's working coast to thrive in a flood-prone area.

The Congressional Budget Office estimated that losses of physical capital from Hurricanes Katrina and Rita totaled between $70 and $130 billion.

How much storm surge and wave energy can barrier islands and wetlands deflect? Recent modeling sheds light on this issue. One numerical model that examined forecasts of barrier island loss from the 1990s through 2020 found dramatic increases in bay wave energy with time even under mild weather conditions (Stone, 2004). The study's models found that in some cases, water conditions behind diminished barrier islands resembled those found in the open sea. Another model examined a different hypothetical situation: what if the wetlands east of the Mississippi River Gulf Outlet, the Gulf Intracoastal Waterway, and Lake Borgne turned into open water eight feet deep? The model found that Hurricane Katrina's storm surge would have been three to six feet higher in St. Bernard Parish and New Orleans East (Working Group for Post-Hurricane Planning for the Louisiana Coast, 2006). In Louisiana's flat, low-lying coastal areas, the incremental reductions in storm surge and wave energy provided by coastal landscape features, working in concert with hurricane protection structures, can mean the difference between an area that survives a storm and one that suffers catastrophic damage.

Lessons from the Storms

Hurricanes Katrina and Rita showed just how much these degrees of flood protection can mean. In New Orleans after the levees failed, just one or two feet of extra elevation were enough to keep some homes dry, while lower homes a few blocks away filled with water. But even though some fared better than others, for most residents of coastal Louisiana the loss of life and property remain devastating realities. Statewide, over 200,000 homes sustained major or severe damage, and approximately 440,000 Louisiana citizens were still displaced from their homes one year after the storms (Louisiana Recovery Authority, Aug. 2006). Hundreds of schools, hospitals, and churches were also damaged or destroyed.

In addition to human impacts, the storms had dramatic effects on south Louisiana's wetlands themselves. A study by the U.S. Geological Survey (USGS) reports that the storms converted approximately 217 square miles of marsh to water. Of this total, 98 square miles of land were lost in southwestern Louisiana, and 119 square miles were lost in southeastern Louisiana. Analyses of future growing seasons will indicate how much of this damage is permanent. Marsh plants may rebound in some spots and not in others. Regardless of the final outcome, the storms have aggravated an already dire land loss emergency.

National Resources

Energy infrastructure. The oil and gas industry has established a concentration of coastal and offshore infrastructure and refining capacity in and near south Louisiana. Nearly 9,300 miles of pipelines cross the marshes of coastal Louisiana (USACE, 2004). The Henry Hub in Erath, Louisiana, is the pricing point for natural gas throughout North America, and Port Fourchon provides a port and supply point for hundreds of offshore drilling operations in the Gulf of Mexico. The network of energy facilities located in and around the wetlands produces or transports nearly one-third of the nation's oil and gas supply and is tied to 50% of the nation's refining capacity (LA Department of Natural Resources, 2006). Barrier islands and wetlands help buffer this infrastructure from storm damages.

The network of energy facilities located in and around the wetlands produces or transports nearly one-third of the nation's oil and gas supply, and is tied to 50% of the nation's refining capacity.

The Storms' Effects Went Far Beyond the State's Borders

The storms' national impacts revealed just how much U.S. citizens depend on the resources and infrastructure found in south Louisiana.

Loss of crude oil and natural gas production in the Gulf of Mexico, along with significant disruptions to 20% of U.S. refining capacity, significantly increased gasoline and heating oil prices for households throughout the nation (Congressional Budget Office, 2005).

Disruptions in offshore oil and gas production reduced supply and forced withdrawals from the Strategic Petroleum Reserve.

The temporary closure of the Port of New Orleans slowed grain shipments from the Midwest, which had ripple effects on world agricultural markets.

Courtesy Donn Young/Port of New Orleans

Container and breakbulk ships line the wharves at the Nashville Avenue Complex and Napoleon Avenue Container Terminal at the Port of New Orleans.

National and international commerce. Ten major navigation routes are located in south Louisiana. Five of the busiest ports in the U.S., ranked by total tons, are also located in this region, handling approximately 469 million tons of waterborne cargo each year. This represents 19% of annual U.S. waterborne commerce (USACE, 2003). Without barrier islands and wetlands, all of this infrastructure would be at greater risk when storms come ashore.

Fisheries and wildlife habitat. Coastal Louisiana has the largest expanse of coastal wetlands in the lower 48 states. This ecosystem is the nation's largest shrimp, oyster, and blue crab producer and provides 26% (by weight) of the commercial fish landings in the lower 48 states (US Department of Commerce 2005). In fact, Louisiana is second only to Alaska in annual volume of seafood landings, and three of the nation's top seafood

Each year, the Port of South Louisiana and the Port of New Orleans together account for $150 billion and 20% of the U.S. import/export cargo traffic. (Dept. of Commerce Service Assessment, 2005).

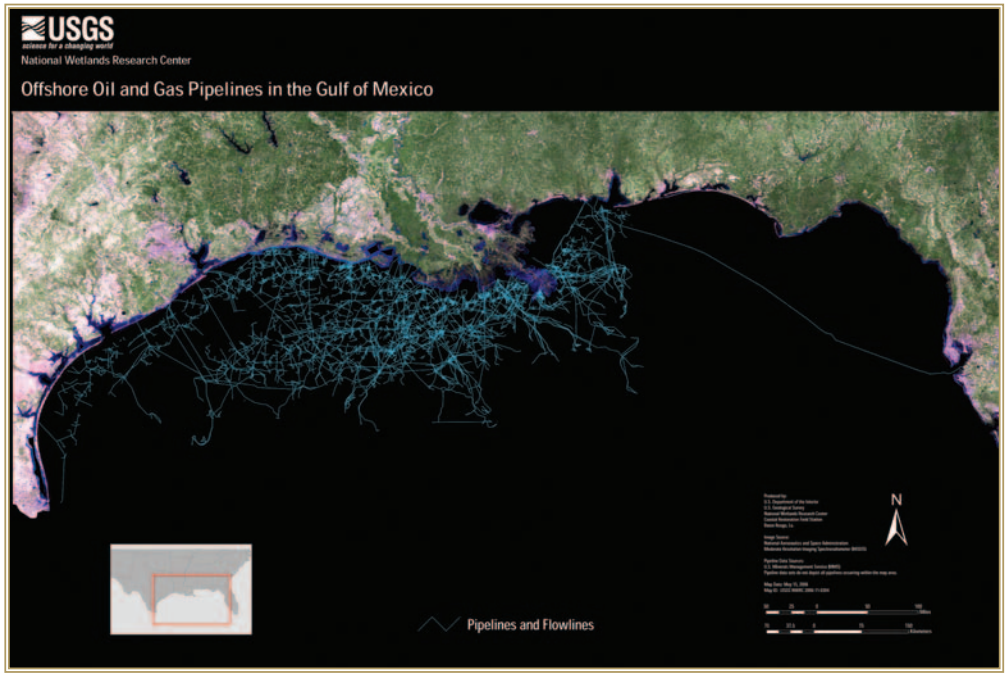


Figure 1. Map of offshore oil and gas pipelines in the Gulf of Mexico (courtesy of USGS).

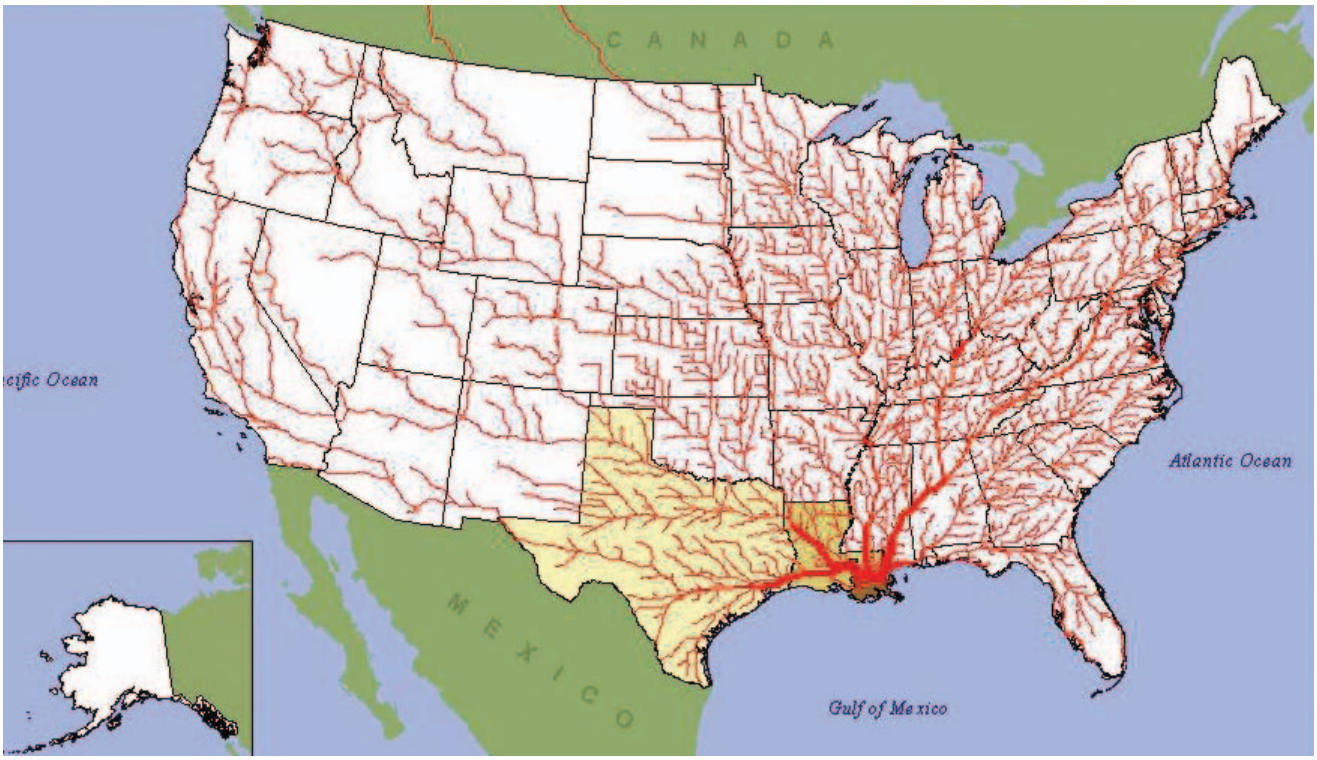


Figure 2: Louisiana's Mississippi River Ports – Inland movement of maritime cargo by truck. (courtesy FHWA)

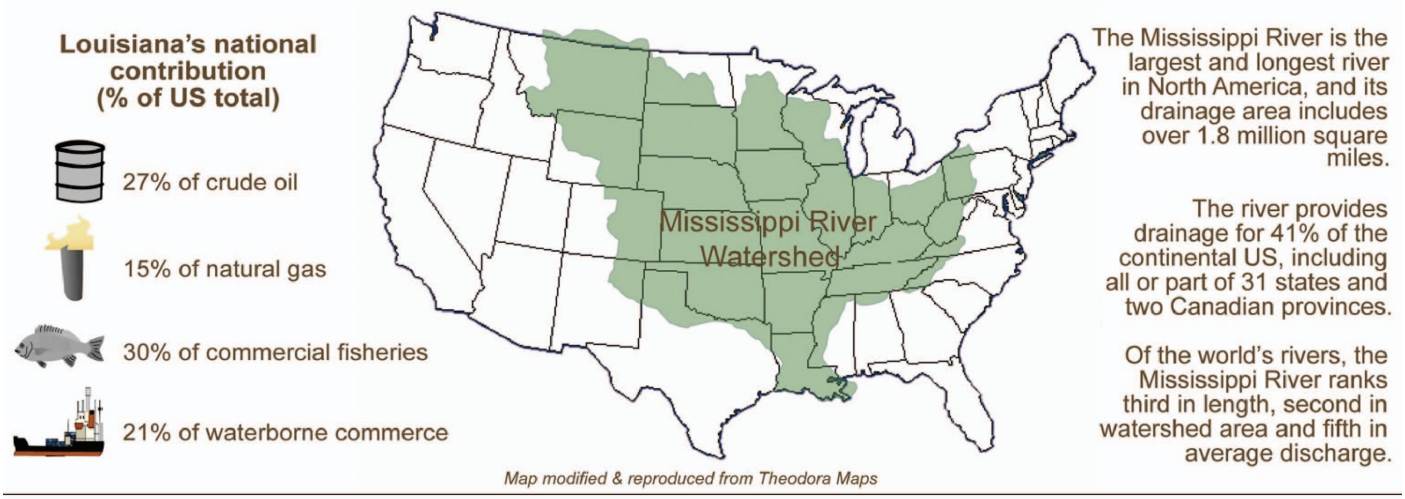


Figure 3: Louisiana's national and international significance.

Louisiana Black Bear crossing stream in South Louisiana.

ports by volume are in Louisiana (US Department of Commerce 2004, 2005). These resources are processed and shipped throughout the world, providing jobs for almost 30,000 Louisiana citizens as well as jobs in other states (LA Department of Wildlife and Fisheries, 2005).

The North American Flyway passes directly over south Louisiana, and more than five million migratory waterfowl spend the winter in Louisiana's marshes (LA Department of Wildlife and Fisheries, 2000). In addition, the coastal landscape provides stopover habitat for millions of neotropical migratory birds on their journeys across the Gulf of Mexico. Hundreds of fish and wildlife species, as well as the jobs and recreational opportunities associated with birding, hunting, fishing, and eco-tourism, all depend on the barrier islands and wetlands found in south Louisiana.

Shrimp boats docked after coming in from the Gulf.

Seventeen endangered or threatened species are found in south Louisiana, including the bald eagle, Gulf sturgeon, Louisiana black bear, and several species of sea turtles (USACE, 2004).

Water quality. When river water flows through them, wetlands filter nutrients from the water that would otherwise flow directly into the Gulf of Mexico. High concentrations of these nutrients in the northern Gulf of Mexico contribute to the growing problem of hypoxia, or low oxygen conditions, in offshore coastal waters. As increasing amounts of river water are diverted into marshes as part of restoration projects, these nutrients will help sustain wetland plants or be processed in the soil, rather than contributing to a nationally significant water quality problem (see Chapter 2).

Courtesy Bruce Schultz, LSU AgCenter

Cattle ranching has been a part of Vermilion Parish's history since the early 1800's.

Culture. People have lived in south Louisiana for over 12,000 years, using the abundance of the rivers and coast to extract resources and facilitate trade. When New Orleans was founded 300 years ago, it quickly became a center of international commerce, attracting people from around the world. These diverse peoples lived in proximity while retaining their own identities, a trend that defied typical melting pot dynamics and created a multi-faceted culture that endures today.

The Chitimacha people have lived on Louisiana's coast for at least 2,500 years and state as part of their beliefs, "We have always been here." The regard of land and family expressed by this sentiment is one that many residents of south Louisiana share. In fact, according to the 2000 Census, Louisiana has the highest percentage of native born residents (79.4%) of any state in the nation.

Port Fourchon currently services over 75% of the Gulf of Mexico deepwater oil production.

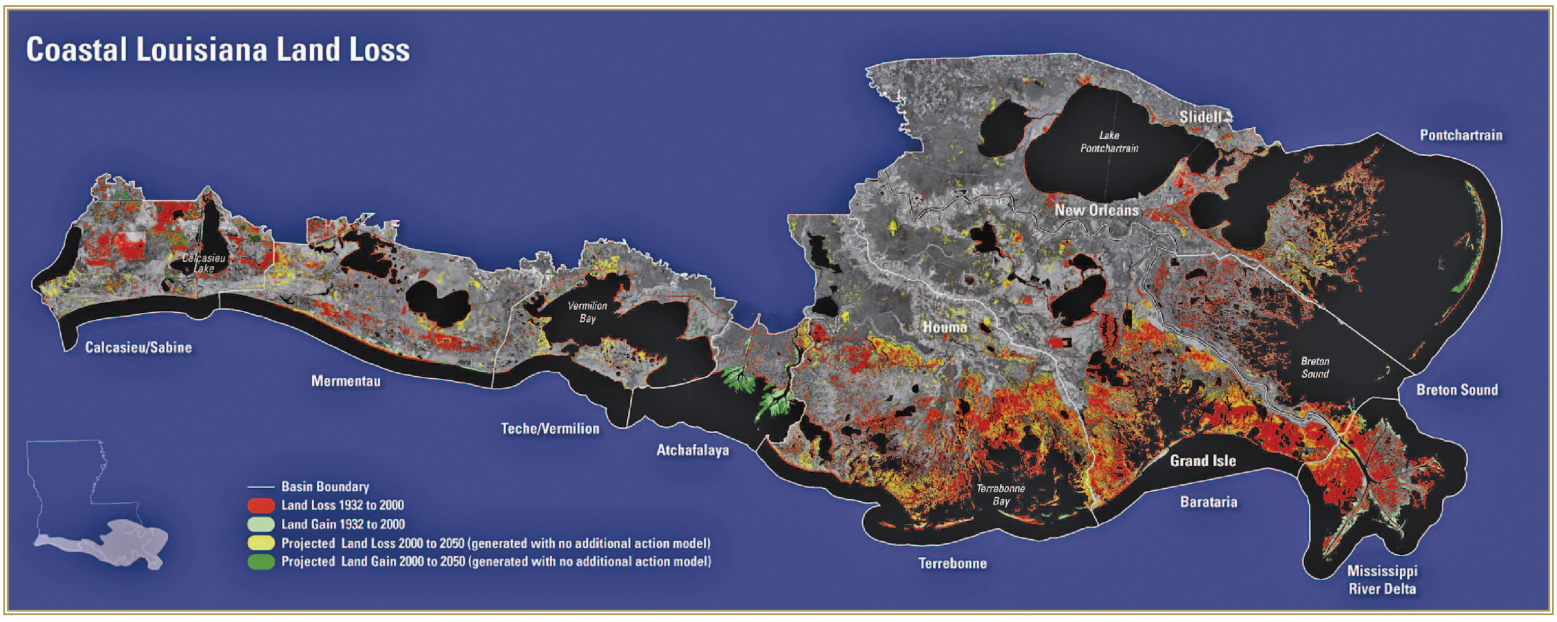
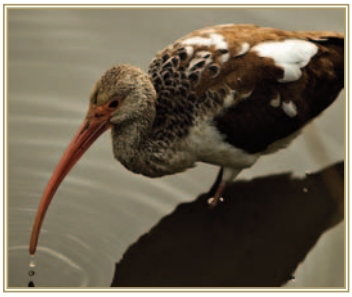


Figure 4: Land change in coastal Louisiana. Red and yellow indicate past and projected land loss; greens indicate past and projected land gain. Barras et al. 2003

Between 1932 & 2000, coastal Louisiana lost over 1,875 square miles of land, and scientists estimate that the state will lose an additional 513 square miles by 2050. Approximately 24 square miles of Louisiana land turn into open water each year, enough to endanger human communities and essential habitat (Barras et al., 2003).



Courtesy Scott Russell Photography

Whether or not these citizens are able to maintain their connection to the region depends on how quickly the state can find ways to rebuild wetlands and provide adequate storm protection.

Louisiana's working coast, America's Wetland, supports vital ecosystems, national energy security, a unique culture, and thousands of jobs. However, the region is changing before our eyes, threatening benefits we have relied upon for decades.

Losing Ground

Humans have altered Louisiana's coastal ecosystem for centuries, and these changes have allowed our communities and the nation to prosper. However, the unintended effects of these changes have now reached a critical mass that threatens not just the health of the natural systems but life in south Louisiana as we know it. Our challenge: to promote a sustainable coast that allows both human and natural communities to thrive over the long-term.

Until the late 19th Century, the Mississippi River's floods regularly spread water and sediment across southeast Louisiana, helping to expand the Delta Plain, replenishing swamps and marshes, and creating an ecosystem that endured for thousands of years. But in the last century, the river has been contained within channels. The river's water, sediment, and nutrients, all vital land building resources, are now funneled into the Gulf of Mexico. Because the wetlands do not receive the materials that allow them to regenerate, they become waterlogged, sink, and turn into open water. Rising sea level, regional subsidence, saltwater intrusion from man-made channels, and a host of other factors all increase stress upon an already burdened ecosystem.

The Chenier Plain in southwest Louisiana was built by the waxing and waning of the Mississippi River's influence in the area. Ridges composed of shells and sand lie along the Gulf shoreline and support maritime forests. The predominance of oak trees on these ridges gave the region its name; "chene" is the French word for oak. The Chenier Plain has its own set of unique land loss challenges, many of which have not been explored as fully as those in the Delta Plain. The Chenier Plain is also used differently than the delta; the population is dispersed throughout the inland area, and most of the land north of the coastal zone is used for agriculture. For these reasons, freshwater allocation among agriculture, municipal, industrial, and ecosystem demands is a major concern. Some citizens recall that after Hurricane Audrey's storm surge came inland in 1957, it was 10 years before farm production returned to pre-storm levels. Residents are now wondering how many years will pass before the soil has recovered from Hurricane Rita's surge.

Change	Benefits	Tradeoffs
Levees and other structures built to control the Mississippi River.	Provided flood protection as well as navigation, and expanded the land available for development in areas such as New Orleans.	Reduced the flow of water and sediment into deltaic wetlands and the Chenier Plain; thereby destabilizing coastal landscapes.
Canals and navigation channels dredged; rivers in the Chenier Plain straightened and deepened.	Allowed shipping as well as oil and gas production to flourish; provided for greater flood control; further established south Louisiana as an international center for trade and industry.	Changed the way water flows in the region, increasing saltwater intrusion, reducing retention of fresh water in the Chenier Plain, and accelerating land loss.
Forced drainage of wetlands.	Increased land available for development.	Promoted rapid sinking of land, and increased the number of people and assets at risk.

Courtesy Bruce Schultz / LSU AgCenter

Longshoremen loading rice onto a ship at the Port of Lake Charles.

Implications

If sustainability is not restored to the coastal ecosystem, land will continue to be lost at a rapid rate, and critical infrastructure will be damaged or destroyed. Pipelines, offshore support centers, and other facilities constructed for inland conditions will be subject to the open water of the Gulf of Mexico. Should these trends continue, the nation can expect disruptions in the delivery and pricing of crude oil and gas. As we saw after Hurricanes Katrina and Rita, these conditions may destabilize the nation's economy.

Shipping will be similarly affected. As wetlands become waterlogged and disappear, storm surges will batter south Louisiana's waterways and ports. Maintenance costs will increase, as will disruptions in commerce.

Natural resources will suffer as well. Fisheries and wildlife stocks, including threatened and endangered species, will decline as spawning, breeding, and foraging grounds are lost to the Gulf. Not only will consumers encounter rising prices and shortages of resources that are readily available today, but the nation will lose priceless habitat whose intrinsic value is recognized the world over.

The gradual loss of south Louisiana communities presents other costs. As repeated flooding makes living near the coast more difficult and people migrate inland, historic villages and towns that were originally located on high ground will be abandoned. Louisiana has already lived through the catastrophic scenario in which hurricanes claim over 1,400 lives and tens of billions of dollars worth of property. The everyday catastrophe of continued land loss further threatens the viability of coastal communities throughout south Louisiana.

When one considers the human cost, the risks to infrastructure, and the danger to wildlife and landscape, it is clear that we must take bold action. Significant upgrades to our hurricane protection systems are clearly in order, but levees alone cannot do the job. A sustainable coastal ecosystem will help storm protection projects diffuse flooding while safeguarding the infrastructure, fisheries, and communities that are integral to our state and national security. In addition, wiser land use practices must govern the way we live in this dynamic landscape if we are to create safe communities that thrive over the long-term.

Implementing this comprehensive solution will require one of the largest public works programs our nation has ever undertaken. And while Louisiana is willing to pay its fair share of the cost, federal funds will also be needed. Such assistance is not a handout, but rather an acknowledgement that south Louisiana's coast was altered so that it could better serve national energy and navigation interests. It only makes sense, therefore, that having benefited from Louisiana's geography and resources for over 200 years, the nation will invest in restoring the ecosystem and protecting the coast's defenses.

Dredged sediments being placed in open water to restore marsh that has been lost.

Chapter 2: Assumptions, Tradeoffs, and Challenges

Assumptions of the Master Plan

- The Master Plan is a living document that must be continually updated as we learn more about how to protect and restore Louisiana's coast.
- A healthy landscape is essential to achieving both a sustainable ecosystem and reliable flood protection.
- Change is inevitable whether or not we take action. Therefore, we must embrace actions that allow us to create a sustainable future.
- A "multiple lines of defense" strategy should guide flood protection decisions.

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Head of Passes – Looking south to the Gulf of Mexico from the mouth of the Mississippi River.

Plans that will affect the lives of millions of people, as this one will, are not designed in a vacuum. Not only have citizens and stakeholders taken part in all aspects of developing this document (see Chapter 3), but a variety of external mandates and constraints have also shaped the plan's development. For example, Act 8 requires that the Master Plan be comprehensive in scope—not simply tweaking existing ways of protecting, restoring, and managing the coast, but recommending large-scale solutions to problems that have not been solved by smaller, localized efforts. Other factors involve hard choices related to land use and fisheries. In addition, climate change and other technical issues pose complex challenges as we proceed. Because these external factors exert a strong influence, we must be clear about what they are and how they are affecting the direction and scope of the plan.

Basic Assumptions

As the Integrated Planning Team and its partners sought to balance the many factors involved, they relied upon four assumptions to guide their work.

First, the Master Plan only offers a snapshot of the current thinking about coastal protection and restoration. The planning team based its recommendations on ideas that have been widely circulated and discussed as part of Louisiana Coastal Area activities, previous hurricane protection initiatives, and other efforts. In this sense, the planning team did not start from scratch, but rather attempted to take well-established ideas about flood control and coastal restoration to a new level. At the same time, the planning team attempted to think outside of the box and identify areas, such as new levee technology, where innovation is needed. In these cases, the intent was to highlight key uncertainties and encourage engineers and scientists

to advance the state of the art. Because it is constrained by what we know today, this plan must be revised as we learn more. In other words, this version of the Master Plan is a first cut at what will be a living document that changes over time.

Second, a sustainable landscape is a prerequisite for storm protection and ecological restoration. This does not mean that we attempt to freeze south Louisiana into one configuration forever, which would be impossible given the inherently dynamic nature of the coast. It does mean that we stop the severe wetland loss that is changing our communities and ravaging the landscape. Without a sustainable landscape, it will be extremely difficult to maintain human communities, much less provide sustainable hurricane protection into the future.

A third assumption involves the inevitability of change. The system is changing now, changing so quickly in fact, that unless we take action soon the nation will lose one of its most ecologically productive and economically vital regions. At the same time, everything we do to fix the problem will also alter the ecosystem. The way water flows, the salinity of the water, how much sediment it contains—all of these characteristics will shift as we take action. Given that seemingly small alterations can have big long-term effects, those working on the coastal program must understand the impacts of proposed actions and make sure that all changes are accounted for and used to maximum advantage. Equally essential will be rigorous monitoring and assessment in order to integrate lessons learned into the program.

Fourth, plans for hurricane protection must rely on multiple lines of defense. This involves using natural features such as barrier islands, marshes, cheniers, and forested ridges to complement man-made structures such as highways, levees, and raised homes. Such an approach avoids reliance on single protection measures, which, if compromised, would leave vulnerable areas without recourse. Residents of coastal Louisiana have used a multiple lines of defense strategy for thousands of years, building homes and settlements on high ground that was protected by natural ridges, barrier islands, and more recently by levees. Using this strategy as part of a comprehensive protection and restoration program thus expands the scale of what is already a regional tradition. With this expanded scale come issues of coordination, given that protection and restoration measures must work in concert with each other and with local land use and zoning regulations.

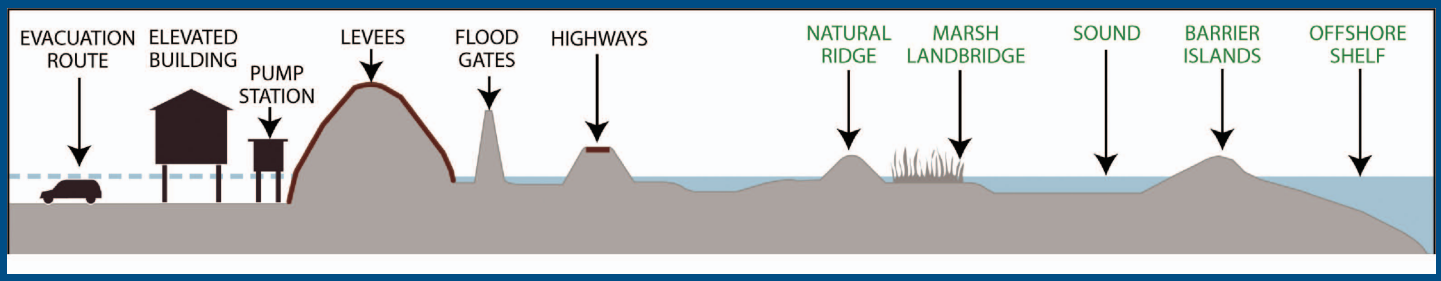


Figure 5: Multiple lines of defense concept (adapted from graphic produced by the Lake Pontchartrain Basin Foundation).

Citizens participated in the LRA Louisiana Speaks workshops held across coastal Louisiana. Input on alternative coastal plans helped shape the master plan's preliminary draft issued in November 2006.

Using the multiple lines of defense approach also requires that large tracts of coastal landscape remain sustainable. As a result, this approach presupposes a strong emphasis on ecosystem restoration and on the restoration of entire basins.

These concerns may sound relevant only to planners, scientists, or citizens living near the Gulf. But over time, changes made to the coast will affect all residents of Louisiana and the nation. Where seafood can be caught, where land can be developed, how high homes must be built, the cost of storm recovery, and the need for and availability of insurance—all of these factors and more will shift as we take action. In other words, protecting and restoring our coast is not a job reserved for specialists. This underscores the need for partnerships among all levels of government—federal, state, and local—as well as the public. Because everyone will be affected, everyone has a stake in helping to shape the program and put it into practice. This communal responsibility is most evident when we consider the hard decisions that must be made as we seek to create a sustainable coast.

Implications

Recognizing that changes are unavoidable if we want to continue living in south Louisiana, a spirit of common purpose is imperative. We are living in an historic moment, one that presents us with a stark choice: either make the bold and difficult decisions that will preserve our state's future, or cling to the status quo and allow coastal Louisiana and its communities to wash away before our eyes. There is no longer any time to waste. We must act now or forfeit the possibility that our children and grandchildren will be able to share the life, culture, and resources that are so precious to us and so important to the nation.

At the same time, we cannot simply expect hard working residents of the coast to make costly sacrifices without support. We must work together to manage the coming changes. Actions such as adjusting zoning laws to support flood control and land building, providing information well in advance of possible impacts, and exploring avenues for fair compensation to those who will be directly impacted are all ways to help our communities adjust to the new future we are creating for our state. The examples below offer more details about the issues at stake.

Fisheries. Because the Mississippi River is contained in levees and no longer overtops its banks in regular floods, the wetlands throughout the Deltaic Plain do not receive the sediment and water they need to regenerate. As a result, areas that were land are fast becoming open water. Reconnecting the river to the wetlands using large-scale river diversions will help the wetlands rebuild and reduce rates of land loss.

As sediment rich fresh water enters the system, areas that are suitable habitat for resources such as oysters and shrimp will shift. On the other hand, if we do nothing, land in southeast Louisiana will continue to fragment and sink, claiming habitats and increasing flood risks in inland areas. In the coming decades, and possibly within just 25 years, the habitat may deteriorate to the point that important fisheries are no longer viable. In a very real sense therefore, we must accept that fishing locations will need to change in order to provide a sustainable landscape over the long-term.

Protection Levels

Category 5? 100 Year Storm? 1% Annual Chance of Occurrence?

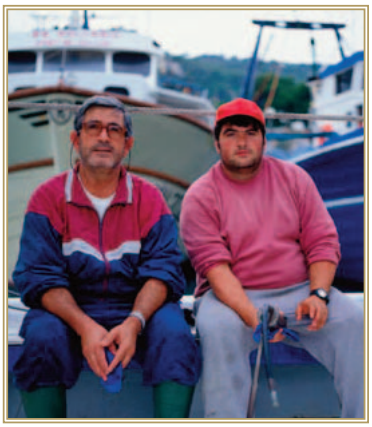
How are all these concepts related, and how can they be used to define expected levels of protection? "Category 5" is the highest level of the Saffir-Simpson hurricane index and indicates a hurricane with maximum sustained winds above 155 miles per hour. Since it is indexed solely to wind speeds, this does not accurately reflect the true nature and source of the primary threat to coastal Louisiana—the storm surge. The magnitude of the storm surge is not only related to wind speed, as any witness of the damage caused by Hurricane Katrina may attest. Hurricane Katrina, a Category 3 storm at landfall, had a much larger storm surge than Hurricane Camille, a Category 5 storm at landfall.

For this reason, we define levels of protection in this document in terms of the annual probability that a given storm surge will be experienced. Just as there is a 50% chance of getting "heads" each time a coin is flipped, a 1% storm surge actually refers to the probability of the surge occurring in any given year. Likewise, just as it is possible to flip "heads" several times in a row, it is possible to have a "1% storm surge" in consecutive years, or even more than once within the same year. However, over thousands of years, a "1% storm surge" should occur, on average, once in 100 years.

For example, analyses by the Corps of Engineers have concluded that a surge of the same magnitude as Hurricane Katrina's has a 0.25% chance of occurring in any given year, or an average of once in 400 years, in New Orleans. Similarly, a surge of the same magnitude as Hurricane Rita's has a 1.1% chance of occurring in any given year, or an average of once in 90 years, in New Orleans. Probabilities have not yet been computed for the extreme surges that Cameron Parish and other areas in western Louisiana experienced during Hurricane Rita.

Levees. Not every south Louisiana community that wants levee protection from the largest of storms will get it. In some areas of the coast it would be difficult if not impossible to build and maintain these types of structural protection systems. In addition, there are simply not enough federal or state dollars available to make this solution feasible. As a result, communities with dense concentrations of assets at risk, such as New Orleans, Houma, Lafayette, and Lake Charles, will receive a greater level of structural protection than will other communities. Wherever we build levees, we must make sure that the landward wetlands remain healthy and connected parts of the overall coastal ecosystem. This will require innovative engineering as well as constant monitoring and assessment. In addition, levees do not protect against wind damage, so south Louisiana residents will always need to take additional precautions to protect life and property.

Even though they will not all receive higher levees, other south Louisiana communities will not be left to fend for themselves. An analysis of the areas and assets at greatest risk has led the state to target, as a baseline, a coast-wide level of protection that would withstand a storm surge with a 1% chance of occurring in any given year. However, this goal will not be met immediately and not all of the needed protection will be provided by levees. Some will be provided by land building projects working in conjunction with storm protection measures, including improved evacuation routes that double as storm surge barriers, raising homes, and other non-structural construction methods. Certain aspects of this non-structural protection will be accomplished as citizens elevate homes and businesses and take other steps to protect their property. In all cases, the state's aim is to tailor the measures adopted to the specific needs of individual communities while basing all of our actions on sound science and engineering.



Land use. The centuries old tradition in south Louisiana was to live on high ground and leave wet areas wet. In recent decades, this tradition held less sway, as people began filling in and developing low-lying areas. We now know that allowing development in low-lying areas within hurricane protection systems not only increases a community's exposure to damage in the event of a levee failure, but also removes temporary water storage areas that would otherwise be able to accommodate water from rainfall. Such water storage areas can also limit damage if water overtops a levee. Maintaining this important buffer zone through smart growth is critical (see Chapter 3, "Minimizing Risk").

As these examples show, we must make important shifts in the way we use the coast, while at the same time reducing dislocation and economic hardship for south Louisiana citizens. These changes, as difficult as some of them will inevitably be, also present us with new opportunities—opportunities to fashion a coast that allows both human and natural systems to thrive over the long-term.

Climate Change

The most recent report of the Intergovernmental Panel on Climate Change (IPCC) makes clear that scientists are in all but unanimous agreement about the reality of global warming. There is, however, still debate about how the new trends are manifesting. Recent assessments show a significant increase in North Atlantic hurricane frequency since 1995 (Webster et al., 2005). This analysis also indicates an increase in the number and proportion of strongest category 4 and 5 hurricanes in the late 20th Century.

Sea level trends are more certain. Since the beginning of high-accuracy satellite altimetry in the early 1990s, tide gauges and altimeters have shown global mean sea level to be rising at a rate of just above 3 mm/year, compared to a rate of slightly less than 2 mm/year over the previous century (IPCC, 2007). The IPCC's 2007 report further estimates that in the next century, future sea level rise rates may be anywhere from 2 to 6 mm/year higher than present rates.

We are living in a historic moment, one that presents us with a stark choice: either make the bold and difficult decisions that will preserve our state's future, or cling to the status quo and allow coastal Louisiana and its communities to wash away before our eyes.

Coastal Louisiana will be among the first places in North America to feel the effects of global warming. Its low-lying coast will be directly impacted by rising sea level and more frequent hurricanes. Longer dry periods and more intense storms linked to global climate change would further stress some of the more highly managed wetland areas of coastal Louisiana. Larger storms will drive more salt water into fresh systems that are unable to flush it back out because of the lack of drainage, rainfall, and fresh water input from rivers. And the longer salt water remains in the wetland system, the harder it will be for the vegetation to recover after a storm surge.

Other changes, such as shifts in river flows, may be more subtle. Because the Mississippi River drains 40% of the continental U.S., climate changes upriver in the Mississippi Basin could change the timing and delivery of water and sediment to the Deltaic Plain. The link between Louisiana and the larger Mississippi Basin complicates predictions of the effects climate change will have on Louisiana's coastal zone.

Relative sea-level rise is the term used to express the combined effect of both subsidence and sea level rise. In Louisiana the problem of rising sea levels is compounded by the gradual sinking, or subsiding, of our coastal lands. When land surface in south Louisiana subsides, more sediment is needed to build and maintain wetlands and barrier islands to the original, higher elevation. And as the land surface moves down, so do the elevations of levees and flood protection structures, requiring more maintenance to keep them at their design heights. Fortunately, most projections of relative sea level rise show that this trend is within the wetlands' abilities to cope, especially if actions are taken to re-establish natural land-building processes (Day et al., 2007; Day et al., 1995; Reed, 2002; Scavia et al., 2002; Twilley et al., 2001).

Courtesy Scott Russell Photography

However, in the Chenier Plain, the climate change trends of rising sea level and higher temperatures are compounded by projected changes in rainfall that could lead to longer dry periods. These trends would exacerbate the region's already serious lack of freshwater resources. These kinds of yearly changes in the availability of fresh water and sediment, as well as other long-term trends that may be associated with climate change, reinforce the need for the Master Plan to explore aggressive ecosystem restoration measures. In addition, the actions of this comprehensive restoration and protection program must be effective under a range of climate change scenarios.

Other Technical Challenges

Years of research, modeling, and project construction have identified the fundamental protection and restoration options available, and it is now time to accelerate efforts to put this knowledge into practice. As we move closer to building larger and more comprehensive projects, our need for detailed information will increase. At the same time, Louisiana's coast is changing constantly, and data quickly become outdated as conditions shift, both because of factors intrinsic to coastal processes and because of the effects of global warming.

We will have to proceed in stages, field testing new concepts and learning as we go. There will inevitably be failures and course corrections, but experience gained will help us improve subsequent efforts. Restoring a dynamic landscape of this size has never before been attempted. Given the magnitude of the task at hand, a stepwise process based on sound science and engineering is the only way forward.

For example, rates of subsidence throughout south Louisiana vary, even within the same general areas, and the state and its federal partners are working now to gain a more accurate picture of regional subsidence rates. The causes of subsidence are also under study, as are the interrelationships between subsidence and sea level rise. Such complexities encourage scientific exploration, but they also make it difficult to issue hard and fast predictions about how a given area will be affected by protection and restoration measures.

All of these factors together create enormous science and engineering uncertainties that need to be resolved. Some of the immediate technical challenges facing the state are summarized below.

When hurricane protection systems are placed across estuarine basins, they change the way surface water flows.

What does the science and engineering tell us? When hurricane protection structures were placed across estuarine basins in the past, they altered patterns of marsh flooding. By keeping water from moving inland, such structures reduce high water levels. This in turn reduces the frequency with which new sediment and nutrients spread across the marsh surface. Placing appropriately sized river diversions landward of the hurricane protection structures may compensate for some of these effects. But hurricane protection structures may also hold water in, and so another challenge involves making sure that introduced water does not excessively flood inland wetlands or harm communities. If structures are overtopped with salt water, as occurred in the Chenier Plain during Hurricane Rita, the water must be removed quickly so that the wetlands can recover.

Urgent Call to Action: Develop Next Generation Hurricane Protection Systems

Future hurricane protection systems must rely on new technologies that bear little resemblance to traditional earthen levee embankments. Levees must be built with innovative designs, since we now recognize the importance of tidal exchange and natural hydrology in sustaining wetland ecosystems. The challenge is significant; some have equated it with rewriting the engineering textbooks for flood control. But this challenge must be met if over two million people are to continue living and working along Louisiana's coast. As researchers and planners explore new options, they should keep these principles in mind:

- Use innovative technology to build hurricane protection systems that minimize disruptions to tidal regimes and hydrology.
- Keep entire basin systems functional and sustainable by integrating landward diversions, drainage structures, and other environmental projects into hurricane protection systems.
- Ensure that strict land use controls are enforced. Wet areas must stay wet, and community growth must be managed to minimize impacts on wetlands and risks to life and property.

What questions remain? We need to know more about how diversions and levees can be designed to sustain the coastal landscape of Louisiana. How can we size and operate diversions to achieve sheet flow over the marsh? Can drainage structures placed in levees help move water out so that it is not held too long or at too high a level? If the levees are overtopped during a storm, will salt water have a long-term destructive impact?

What is the state doing to answer these questions? The state is working with federal partners to monitor the long-term recovery of wetland systems affected by Hurricanes Katrina and Rita. The data collected will offer valuable real-world information about the storms' effects.

The state is also working to improve existing models so it can more accurately assess how water moves throughout the region. Different regions of the coast have different modeling needs, and improving models for each is a long-term proposition. However, the state is funding research in partnership with the Corps and others to fill this need as quickly as possible. The state also needs to construct demonstration projects that

serve as clinical trials of large-scale measures to protect and restore the coast. With improved models in hand, along with the results of demonstration projects, we will be able to better evaluate the effects of various alternatives. As we learn more about how our concepts will work in practice, we will fine tune our restoration and protection plans.

Multiple river diversions operating simultaneously will freshen estuarine basins.

What does the science and engineering tell us? We know that more sediment is available in the Mississippi River at certain times of year, and that diversions can be turned on when sediment is plentiful and turned off when it is not. Using a diversion in this way is called pulsing. Coordinated pulsing of several diversions at once should allow us to take maximal advantage of available sediment, while moderating effects on habitat diversity. Although this technique helps protect and sustain existing wetlands, it could take decades for new land to be built with new diversions alone.

What questions remain? We need to know more about the effects of coordinated use of diversions. How much sediment can be moved? What effects will this have on habitat? Will we take too much water out of the Mississippi River and make it difficult to meet flood control, navigation, and water supply needs? Twenty-five years from now, after climate change has affected factors such as sea level rise, what kinds of diversions will we need to meet the sediment and water resource needs of the coast?

Courtesy Donn Young / Port of New Orleans

Stevedores offload containers from the MSC Carolina at the Port of New Orleans in 2007.

Wetland biologist retrieving data from an environmental water monitoring station.

What is the state doing to answer these questions? Improved modeling and observation of demonstration projects can help us plan for the best outcome. Existing river diversions, such as Caernarvon, are already giving us valuable insights into these issues. The state is also working to improve analytical tools, such as the CLEAR models that link water flow with ecosystem function. Although fisheries will change as diversions are brought on line, those affected will be a part of the planning process. National needs for flood control, navigation, and water supply will serve as constraints on planning. Any system we implement will be designed to make sure all needs are balanced.

We need sediment from rivers, navigation channels, and offshore sources to achieve our restoration goals.

What does the science and engineering tell us? Pumping sediments into an open water area can build marsh quickly. This may be a good option in areas like Lafourche and Terrebonne Parishes, which are further from the Mississipppi and Atchafalaya Rivers. However, wetlands that are built via pipeline may not function in the same ways as wetlands built through natural processes. In addition, the technique requires periodic mechanical renourishment or coupling with river diversions to assure sustainability. Finally, pumping in sediment is expensive, and doing it on a large-scale will require that the state make long-term investments in infrastructure.

What questions remain? How much sediment is available in and around the coast? How renewable are these sediments? Where exactly does it make sense to employ this kind of marsh restoration? How can we ensure that wetlands created using artificial means are sustainable?

Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) program personnel at Louisiana State University utilizing map application to analyze output from the landscape change module.

Department of Natural Resources training personnel in data collection protocols for the Coast-wide Reference Monitoring System (CRMS).

What is the state doing to answer these questions? The state is conducting an inventory of available sand resources. The Master Plan recommends that an inventory be conducted for all sediment resources, including the Mississippi River system. Such an inventory should determine just what is available and how renewable the sediment sources are. The state is also conducting pilot projects to compare the results when marsh is restored with dredged material and sustained with river diversions versus marsh restoration efforts that are built without diversions. The results of such experiments would help the state carefully select priority areas for action and improve the effectiveness of future projects.

High nutrient concentrations in the Mississippi River contribute to water quality problems in the Gulf of Mexico.

What does the science and engineering tell us? Diverting river water into coastal wetlands is one of the main tools for restoring the health of south Louisiana's deltaic wetlands. Such reintroductions could be designed and managed to mimic the spring floods that occurred naturally in such systems, providing a seasonal pulse of fresh water, sediments, and nutrients. Diversions could also be run during other times of the year to re-freshen the system. However, nitrogen loading from the Mississippi River watershed is a driver for the spread of hypoxia or low-oxygen levels in coastal waters. These nutrient levels threaten Louisiana's productive coastal fisheries and overall water quality.

Louisiana is a signatory to the Action Plan for Reducing, Controlling, and Mitigating Hypoxia in the Northern Gulf of Mexico (2001). The action plan stated that a 30% reduction of nitrate loading from the mouth of the river into the Gulf was necessary to reverse the growth of hypoxia in Louisiana's coastal waters. These reductions can be achieved through a wide suite of actions, including agricultural management practices, municipal and industrial source reductions, and watershed and wetland restoration.

What questions remain? We need to know more about the effects of diverting nutrient-laden river water into coastal wetlands, and we need to better understand the potential to overload these systems or generate negative conditions such as harmful algal blooms.

What is the state doing to answer these questions? The data from studies of the Caernarvon Diversion and a number of municipal wastewater to wetland projects indicate that we must avoid exceeding the nutrient assimilation rate of particular kinds of wetlands. Under optimum conditions, these case studies show that significant uptake of nitrogen can be achieved, especially in cypress swamps. There are many sources of nutrients in a drainage basin as large as that of the Mississippi River. Therefore, the solution to the problem must not be limited to coastal Louisiana. Reducing nutrient levels both within Louisiana and throughout the Mississippi River watershed can help alleviate concerns about the negative effects of potential nutrient overloading of coastal wetlands and also protect Louisiana's coastal fisheries by reducing hypoxia in the northern Gulf.

These and other issues will continue to be studied as the planning process moves forward. As we learn more, the plan will change to reflect new knowledge gained. The next chapter outlines a conceptual vision for creating a safe and sustainable south Louisiana.

© Bevil Knapp

Sand and silt mixed with water shoot onto the surface of Timbalier Island, a Terrebonne Parish barrier island, as bulldozers spread out the new material.

Chapter 3: The Master Plan

Principles Underlying the Plan

The planning team, working with citizens, scientists, engineers, and government partners, developed a set of overall program principles to guide their work. These principles deal with five major topics:

- integrating coastal protection and restoration to maximize sustainable, cost effective benefits
- involving all affected citizens and stakeholders in developing and implementing the plan
- regularly updating the plan to ensure that it continues to reflect conditions on the ground as well as the best available science and engineering
- handling constraints appropriately so that limits are respected while removing obstacles to progress
- ensuring a good fit between future land use decisions and the plan's recommendations

The full text of these principles is contained in Appendix A of the Master Plan, available online at www.louisianacoastalplanning.org.

This chapter presents the state's vision of the projects that must be undertaken to protect and restore Louisiana's coast. The projects themselves are briefly described, along with the context within which the state made its determinations.

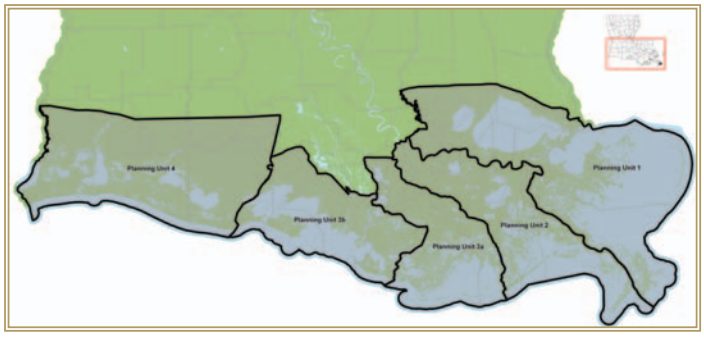
Framework of the Master Plan

The term "Louisiana coast" might sound like a reference to a homogeneous ecosystem. In reality, Louisiana's coastal region contains diverse landscapes, including forested wetlands, barrier islands, marsh, and ridges where humans have lived for centuries. In recognition of this diversity and building on analyses found in the Coast 2050 and Louisiana Coastal Area (LCA) studies, the planning team divided the coast into five distinct planning units. Within each planning unit, the plan offers a strategy for hurricane protection and coastal restoration.

The planning team used a 100-year horizon when assessing the coastal assets at risk as well as options for coastal protection and restoration. This was done to ensure that the plan and its projects would function as intended into the future, providing a sustainable coast for future generations.

The planning team was charged with developing a comprehensive plan that is as cost-effective as possible.

Figure 6: The Five Planning Units (Map)
Five separate planning units were considered for the Master Plan, each representing a distinct hydrologic area.



However, the team was not given a financial ceiling within which all of their recommended projects had to fit. As the plan is implemented in the coming years, the need for swift and effective action must be balanced against fiscal constraints.

Planning objectives. The planning team and its partners developed Coast-wide Planning Objectives that define what the Master Plan seeks to achieve as a whole.

Objective #1: Reduce economic losses from storm based flooding to residential, public, industrial, and commercial infrastructure, assuring that assets are protected, at a minimum, from a storm surge that has a 1% chance of occurring in any given year.

Courtesy Bruce Schultz, LSU AgCenter

Student participating in LSU AgCenter 4-H program to learn about the benefits of the coastal marsh and its ecosystem.

- This may be achieved by implementing plans, projects, policies, and programs intended to provide for hurricane protection and coastal conservation and restoration, including constructing levee and floodgate systems, enhancing natural landscape elements, and by elevating, flood proofing or relocating structures.

- Protection of resources of national and statewide significance will be a priority; including major oil and gas facilities and refineries, deep draft ports and waterways, military and military support facilities, the Gulf Intracoastal Waterway, interstate and other major highways, and historic sites.

- This objective explicitly deals with protection of assets. Effective evacuation procedures must be implemented.

Objective #2: Promote a sustainable coastal ecosystem by harnessing the processes of the natural system.

- A sustainable system is one characterized by high levels of productivity and resilience (the ability of a system to withstand naturally variable conditions and/or recover from disturbances).

- This may be achieved by providing for daily, seasonal, and episodic fluctuations in water levels and salinities, and/or reestablishing natural pathways of sediment movement and nutrient uptake.

- Appreciation of the dynamic nature of the coastal system must be integral to the planning and selection of preferred alternatives.

- Design, construction, and operation of new flood and storm protection measures should avoid or minimize effects that would reduce ecosystem resilience. Where practicable, disrupted hydrologic systems should be rehabilitated to re-establish sustainable processes.

- Project design should promote conditions that route riverine waters through estuarine basins and promote sheet flow over wetlands in order to maximize nutrient assimilation.

Objective #3: Provide habitats suitable to support an array of commercial and recreational activities coast-wide.

- As Louisiana's coastal ecosystem degrades, critical habitat that supports fish and wildlife species continues to be lost. Therefore, the plan will seek to increase the magnitude of suitable fish and wildlife habitats coast-wide.

- The plan will seek to ensure a continued diversity of fish and wildlife habitats coast-wide.

Objective #4: Sustain, to the extent practicable, the unique heritage of coastal Louisiana by protecting historic properties and traditional living cultures and their ties and relationships to the natural environment.

- Louisiana coastal communities are valuable. They are living stewards of the culture, history, land, and environmental resources of the coast for themselves, for the state, and for the nation.

- Sensitivity and fairness must be shown to those in the coastal communities whose homes, lands, livelihoods, and ways of life may be adversely affected by the implementation of any selected alternatives.

- Displacement and dislocation of resources, infrastructure, and possibly communities may be unavoidable under some scenarios. Because of the negative near-term effects some restoration projects may have on the sustainability of existing cultures, careful consideration of mitigation efforts on human disruption must be undertaken.

Process used to develop the plan. Over the last several decades, scientists and planners have done a great deal of work to advance our knowledge about hurricane protection and coastal restoration. The Master Plan planning process sought to integrate all of these efforts into a single vision for creating a sustainable coast, refining techniques, adding new concepts and eliminating outdated ideas as needed. In pursuit of this goal, the following six steps were used to develop the Master Plan. (For a discussion of the complete process, see Appendices B and H.)

Step 1: Specify problems and opportunities. The planning team and its partners outlined what we know about the problems facing coastal Louisiana and what we can do to address them. In order to articulate the plan's objectives, the team built on previous planning studies, research, and the principles and objectives of ongoing programs. Stakeholders were instrumental in outlining these foundation pieces of the Master Plan.

Step 2: Inventory and forecast conditions. The planning team assessed the levels of risk being experienced in coastal Louisiana's communities as well as the current state of the ecosystem.

In addition, the team and its partners projected how these risk levels would change in the future if we take no further action to correct the problems. This analysis provided a sound basis for articulating what the state and nation stand to lose if aggressive action is not taken.

Step 3: Formulate alternative plans. To accomplish this step, the planning team developed two alternative plans. This was done by combining the most promising project concepts into two different approaches for coastal protection and restoration. These alternative plans highlighted the tradeoffs inherent in varying courses of action. For example, the team was able to examine the differences in plans that provided maximum protection for everyone versus more strategic protection. The team also evaluated the difference in plans that relied on continued human intervention in building and sustaining the landscape (by, for example, marsh restoration using dredged sediment) versus a greater reliance on naturally sustaining the coast (by, for example, river diversions).

Step 4: Evaluate effects of alternative plans. The two plans were analyzed for their potential effects on communities and the ecosystem. In addition, the planning team discussed the plans in individual meetings with many stakeholders and in regional meetings convened by the Louisiana Recovery Authority's "Louisiana Speaks" initiative (see below).

Step 5: Compare alternative plans. When combined with stakeholder discussions of the advantages and disadvantages of each alternative plan, the technical analyses quickly pointed to the need to protect communities in proportion to the assets at risk, and to balance rapid land building through with long-term ecosystem sustainability. Plans that rely solely on either restoration or protection activities are not viable, as they do not adequately balance the four objectives.

Meeting of the Federal and State resource agencies and the Scientific and Engineering Review Team held October 2006. Shown is a breakout session focused on the Chenier Plain.

Step 6: Select a recommended plan. Using the analyses described above, the planning team compiled a Master Plan that recommends measures for protecting and restoring coastal Louisiana. The plan presents projects in varying degrees of detail, depending on the current level of knowledge. Some projects, such as the Lake Pontchartrain Barrier Plan and the Mississippi River Delta Management Plan, are conceptual at this point; much more planning and design must be performed before we build these projects. In such instances, the plan offers a menu of representative options now under consideration—with the understanding that the designs will continue to change as they are examined further. Other projects, such as Morganza to the Gulf, have been extensively studied and are ready for construction. In such cases, the plan is able to present more information. However, the plan remains a conceptual document whose contents will change over time as improved technical information is gathered.

Cattlemen join, rice, crawfish and alligator farmers to meet with the CPRA Integrated Planning Team members at a stakeholder meeting open to the public in Abbeville in August 2006.

Timeline: How the Master Plan was Developed

Act 8 Signed	Nov. 2005
Integrated Planning Team established	Feb. 2006
First plan formulation workshops held	May 2006
Plan formulation report completed	June 2006
Plan formulation report included in USACE report to Congress	July 2006
Six LA Recovery Authority Louisiana Speaks workshops held, providing input to Master Plan process	July-Aug. 2006
Over 50 stakeholder workshops and meetings held	July-Nov. 2006
Decision process workshop held with agency partners, science advisors, and NGOs	Sept. 2006
Second plan formulation workshops held	Oct. 2006
Preliminary Draft Master Plan presented for public review; 9 public meetings held	Nov.-Dec. 2006
Technical review panels meet and offer comments on Preliminary Draft Plan	Dec. 2006-Jan. 2007
Draft Master Plan presented for public review; 3 public hearings and 1 public meeting held	Feb.-March 2007
Technical review panels meet and offer comments on Draft Master Plan	March 2007
Final Master Plan submitted to legislature	April 2007

Engaging citizens, stakeholders, agency partners, and technical specialists. The planning team assembled an Interdisciplinary Technical Team made up of representatives from coastal parishes, levee districts, state and federal agencies (including the Corps of Engineers), nongovernmental organizations, and academia. This group reviewed the planning team's work and provided guidance and ideas during workshops held in May and October 2006. Between July 2006 and November 2006, the planning team also held dozens of meetings with stakeholder groups in order to learn which coastal protection measures and approaches were preferred. Details of these workshops and meetings can be found in Appendices B and H of this report available at: www.louisianacoastalplanning.org.

CPRA Integrated Planning Team members answer questions on coastal ecosystem restoration and hurricane protection issues at one of six LRA Louisiana Speaks workshops held in the summer of 2006.

In addition, members of the planning team along with the Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) Program provided the basic restoration and protection scenarios used by the Louisiana Recovery Authority's "Louisiana Speaks" workshops held in July and August 2006. These workshops helped citizens begin defining long-term sustainable visions for the communities of south Louisiana. Ideas shared at the workshops were factored into the planning team's deliberations in the fall of 2006.

A Preliminary Draft Master Plan was created in November 2006, and this draft was shared with the public at nine public meetings held coast-wide in November and December. The planning team also presented the Preliminary Draft Master Plan to two teams of scientists for review. One such team, the Science and Engineering Review Team (SERT), was convened specifically to provide comments on the planning effort. As a result of these outreach activities, the planning team received detailed comments from Louisiana residents, national environmental groups, local and state leaders, engineers, and scientists. Details of these meetings and comments received can be found in Appendix C of this report available at: www.louisianacoastalplanning.org.

All of these comments were integrated into a Draft Master Plan. This iteration of the plan was also presented to the public and scientific panels for review. Three public hearings and one public meeting were held in February and March 2007, and hundreds of citizens again provided feedback. A science and engineering review meeting was held in March 2007. The final Master Plan was produced based on comments received.

Technical Oversight Provided by Two Scientific Panels

A Science and Engineering Review Team made up of internationally known experts in coastal science and engineering reviewed the Master Plan drafts and provided extensive comments. Some members of this panel also attended early plan formulation workshops in the spring and fall of 2006. Membership on this team has expanded in response to new challenges, but as of March 2007, the team's members were as follows:

Gerry Galloway, University of Maryland
Robert Gilbert, University of Texas
Patrick Hesp, Louisiana State University
Shirley Laska, University of New Orleans
Doug Meffert, Tulane University
Irv Mendelssohn, Louisiana State University
Ehab Meselhe, University of Louisiana at Lafayette
Denise Reed, University of New Orleans
Harry Roberts, Louisiana State University
Lawrence Rozas, NOAA, National Marine Fisheries Service
Charles Simenstad, University of Washington
Fred Sklar, South Florida Water Management District
Robert Twilley, Louisiana State University

The Louisiana Coastal Area's Science Board also reviewed the draft Master Plans and process. The board's members include:

Don Boesch, University of Maryland
Conner Bailey, Auburn University
C. Ronnie Best, USGS
Stephen Brandt, NOAA
Robert Dean, University of Florida
William Dietrich, UC Berkeley
Joseph Fernando, Arizona State University
Peter Goodwin, University of Idaho
George Tanner, University of Florida
John Teal, Woods Hole Oceanographic Institution
John Wells, Virginia Institute of Marine Science

Analyses undertaken for this planning effort have shown that the measures outlined below can go a long way toward addressing Louisiana's coastal crisis. Recent modeling results indicate that if all of the Master Plan's restoration projects were aggressively implemented, Louisiana would be able to increase sustainability in significant portions of the coastal zone. These models also show that if the recommended hurricane protection projects were implemented, we may be able to reduce by 90% the potential coast-wide damages from storm surges with a 1% chance of occurring in any given year. Potential coast-wide damages from storm surges with a 0.2% annual chance of occurrence may be reduced by over 80% (see Appendices F and G). Ongoing analyses will help refine the levels of risk facing the coast, as well as recommended levels of protection.

The following sections present the plan's recommendations. Some projects can be constructed while the uncertainties outlined in Chapter 2 are being resolved. As that chapter made clear, we have much to learn about several of the projects proposed in the plan, especially those involving innovative technology. Policy and legislative issues will also influence what can be done. Chapter 4 offers recommendations for handling those uncertainties. To ensure that the plan stays current, the list of projects below will be reviewed and modified regularly in the coming years.

Robert Twilley, Ph.D., Louisiana State University, facilitates discussion at a Science and Engineering Review Team (SERT) meeting as Ehab Meselhe, Ph.D., P.E., University of Louisiana at Lafayette, examines mapping.

Restoring Sustainability to the Mississippi River Delta

As many scientists and policy makers have noted, creating a sustainable deltaic system requires that we reestablish the processes that originally created the landscape. We must reconnect the Mississippi River to the wetlands through diversions and restore flows of water through the wetlands so that the ecosystem can retain sediment and nutrients. Key landscape features, such as barrier shorelines and land bridges, may also need to be restored. Taken as a whole, the measures outlined below offer a framework for achieving these objectives.

Land building diversions. Historically in Louisiana, we managed the Mississippi River for navigation and flood control without understanding the consequences for the ecosystem. The approach outlined in this plan is intended to better balance all of the needs of the region. In order to create new land, science tells us that we must turn the river loose and let it resume doing what it did for thousands of years: spread water and sediment into fragmented marsh and shallow water to create new delta lobes and nourish existing wetlands. Commonly referred to as the Mississippi River Delta Management Plan, this concept involves building very large land-building diversions that will use the majority of the river's sediment and fresh water. This approach is the only way to sustain large areas of southeastern Louisiana.

We do not yet know the best way to accomplish such a major re-engineering of one of the world's great rivers. As a result, this concept must be planned in much greater detail before exact construction recommendations can be made. Some conceptual scenarios for these large diversions are depicted in lower Plaquemines Parish (see Figures 7 and 8). One scenario would place the diversions in the vicinity of Myrtle Grove on the west bank and Phoenix on the east bank. This was proposed by a Technical Group made up of 35 scientists from around the world who participated in the "Envisioning the Future of the Gulf Coast" Symposium in June 2006. Other scenarios have been proposed by stakeholders, including one that places the diversion further downriver in the vicinity of Boothville and Venice. Each option has different advantages and disadvantages, but the issues that must be weighed when determining the final locations include:

- maintaining reliable and safe deep-draft navigation of the river
- ensuring that large diversions do not undermine adjacent river levee sections or flood communities
- placing the diversion so that it builds and sustains the maximum amount of land within the estuarine basins
- taking stock of salinity shifts within basins and how they will affect fisheries and the people who rely on them

How these trade-offs are ultimately resolved will have huge implications for the people who live and work in this region. The good news is that we will be able to anticipate these effects and be proactive in managing them.

Mississippi River Delta Management: Issues to Consider

What does the project accomplish? This project will spur major wetland building in the Barataria-Breton Sound region, which will benefit the ecosystem and provide a degree of storm protection to nearby communities. In addition, introduced sediments and nutrients will increase the sustainability of existing wetlands. This area is important for a host of reasons, including its ability to protect the river communities and the greater New Orleans area from storm surge.

What are the issues involved? There has been much speculation about how the delta management plan would work in practice, but at this juncture, the state does not yet know where the diversions will be, how large they will be, how they will be operated, or how many there will be. Two possible alternative scenarios are shown in Figures 7 and 8, but these are only concepts, and they will undoubtedly change as further research and planning are conducted. We do know that such diversions will change the entire ecosystem and hydrology of the area. As a result, land building, salinities, commercial and recreational fisheries, flood control, and navigation will all need to be factored in to the overall delta management plan.

How can the issues be addressed? Because the delta management strategy is so conceptual at this point, trade-offs and the mechanisms to balance those trade-offs are difficult to define. The state must work with scientists, engineers, stakeholders, and the public to address these complex issues and ensure that our plans are based on the best possible information. Public participation in the planning effort can ensure that the necessary accommodations are made ahead of time to help affected citizens adjust.

What happens if we keep the status quo? Wetlands in the Barataria and Breton Sound Basins are already rapidly converting to water, and this process will continue, increasing the vulnerability of the river communities and the greater New Orleans area to storm damage. The navigation channel of the Mississippi River will also grow more difficult to maintain.

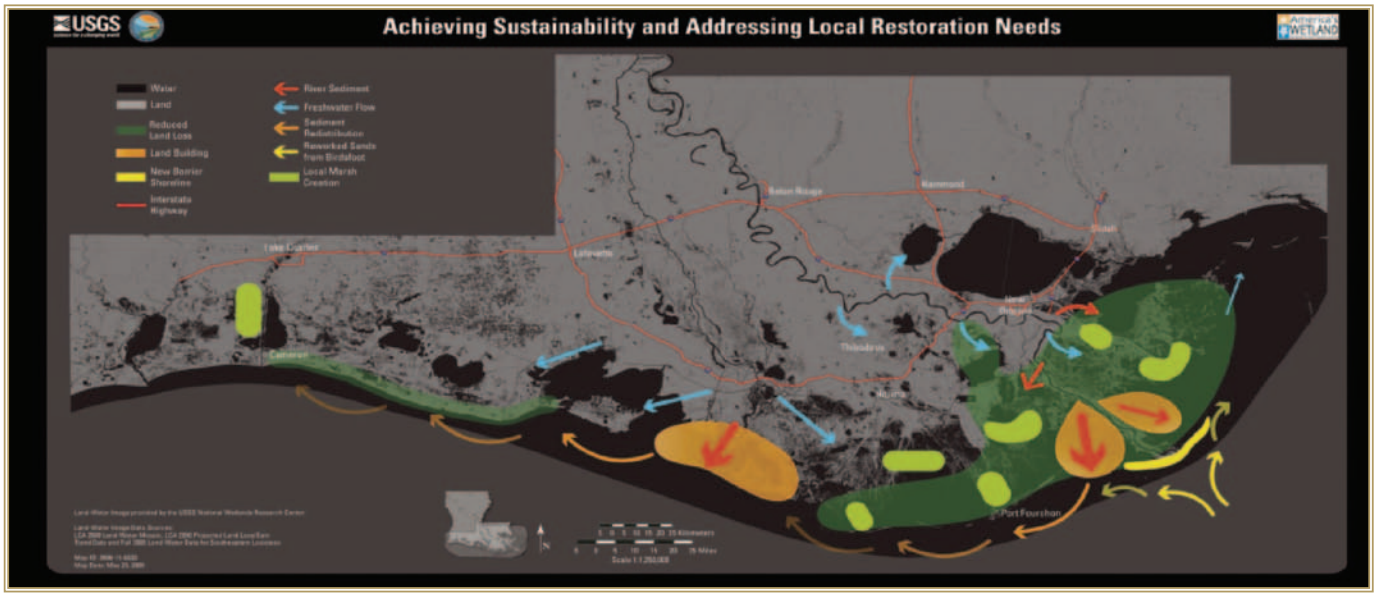


Figure 7: Mississippi River Delta Management—Concept #1
Vicinity of Myrtle Grove on the west bank and Phoenix on the east bank (Technical Group, 2006).

These locations would keep more sediment within the estuarine basins than Concept #2, thereby maximizing the land building capacity of the river. This location would also provide the greatest opportunity for nutrient assimilation by wetland plants, which could help reduce the hypoxia problem in Gulf waters. However, this scenario would create the greatest shift in salinities and would thus change the location of commercially important species. This would affect citizens whose incomes depend upon harvesting saltwater fisheries. There is also concern among residents that this scenario would effectively lead to the abandonment of the towns and commercially important facilities in the lower portion of Plaquemines Parish.

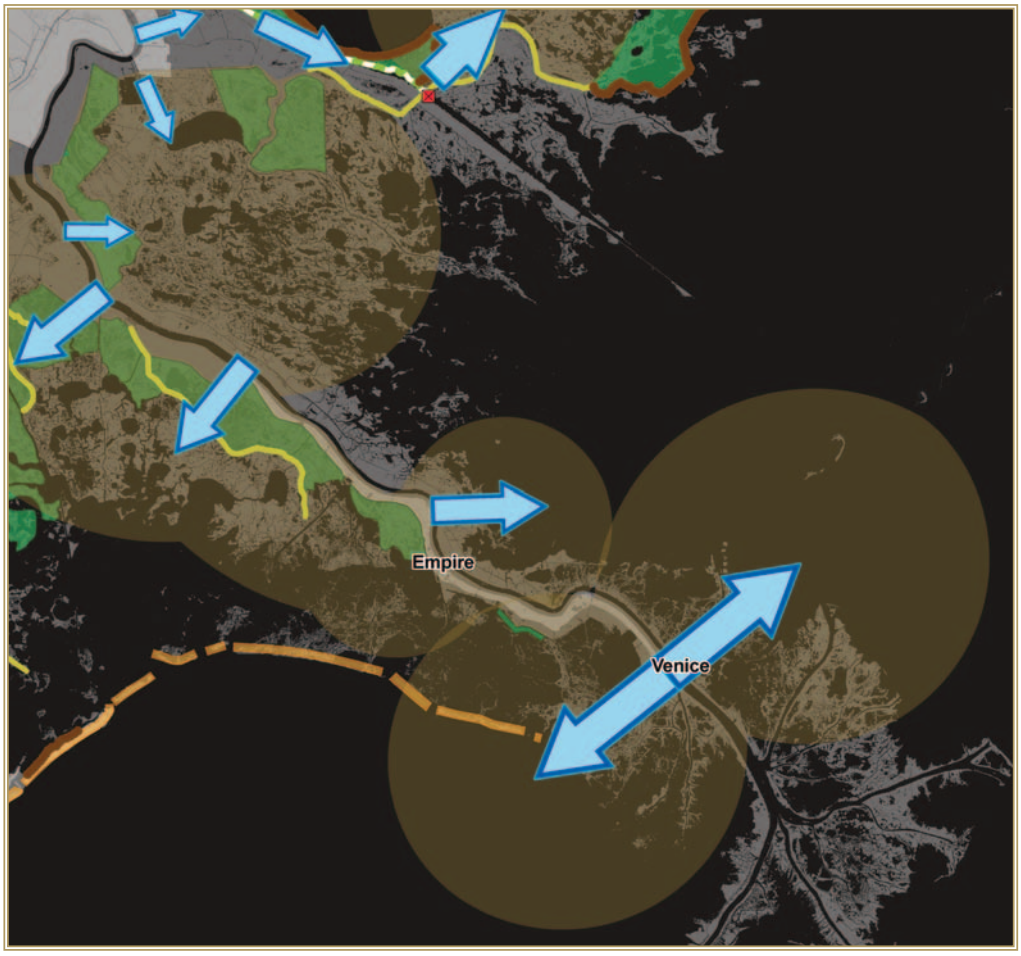


Figure 8: Mississippi River Delta Management—Concept #2, Diversions downriver.

Mississippi River Diversion	- Mississippi River Diversion at Violet - Modify Authorization of Caernarvon Diversion - Mississippi River Diversion at White Ditch - Mississippi River Diversion at Bayou Lamoque - Mississippi River Delta Management - Mississippi River Diversion at Myrtle Grove with Dedicated Dredging - Mississippi River Diversion at West Point a la Hache with Dedicated Dredging
Closure	- Close Mississippi River Gulf Outlet (MRGO) at Bayou La Loutre Ridge
Barrier Shoreline Restoration	- Barrier Shoreline Restoration: Barataria Basin
Marsh Restoration using Dredged Material	- Maintain and Restore the Breton Sound Marshes - Maintain and Restore Biloxi Landbridge and Barrier Reefs - Mississippi River Diversion at Myrtle Grove with Dedicated Dredging - Mississippi River Diversion at West Point a la Hache with Dedicated Dredging - Marsh Restoration using Dredged Material in Barataria Basin - Beneficial Use of Dredged Material
Shoreline Stabilization in Strategic Areas	- Maintain and Restore Biloxi Landbridge and Barrier Reefs - Maintain MRGO-Lake Borgne Landbridge - Grand Isle and Vicinity Shoreline Protection
Navigable Waterway Stabilization	- Mississippi River Gulf Outlet (MRGO) Shoreline Stabilization
Ridge Habitat Restoration	- Restore Bayou LaLoutre Ridge - Ridge Habitat Restoration in Barataria Basin

This scenario, which has been proposed by several stakeholders, would situate diversions near Boothville and Venice. These locations could minimize changes in basin salinities and fisheries. However, the tradeoff may be that sediments are not retained within the Barataria and Breton Sound Basins, which would diminish the land building capacity of the diversions. Further modeling will better describe the potential for this alternative to retain sediments within basins and increase sediment in the longshore current. Further analyses are also required to determine the potential impacts that this scenario would have on salinities and locations of commercially important species.

Notes on Land Sustaining Diversions

- We must ensure that existing diversions, such as Davis Pond and Caernarvon, are used to maximum extent practicable.
- We must operate all diversions as an interconnected system, not project by project.
- Land sustaining diversions are not designed to build land in large open water areas, but to maintain existing land.
- "CFS" stands for "cubic feet per second." This volume refers to the possible flow of water when the river is high; daily flows will fluctuate and may be much lower than this figure.

Land sustaining diversions. River diversions into existing wetland systems can prevent further land loss in targeted areas. The proposed diversions are envisioned as parts of an interconnected system that will be operated as a whole; individual projects will not be operated in isolation. Along these lines, it is important to review the operation of Davis Pond, Caernarvon, and other land sustaining diversions in the Delta Plain. It is a state priority to ensure that these diversions are providing maximal ecosystem restoration results in conjunction with other restoration measures.

One other important note about diversions: the amount of water that can flow through a diversion varies throughout the year, depending on how high the river level is. More water passes through the diversion when the river stage is high, and less water flows through when the river level is low. Diversions can also be controlled to balance the need to sustain land and the need to maximize the diversity of habitats in the landscape (see Chapter 2).

Diversions distribute sediments to areas of need, rather than allowing the sediments to be channeled out of the coastal ecosystem into offshore waters. Another important tool for "getting the sediment right" is distributing these lost sediments through dredging and pipeline conveyance to restore wetlands.

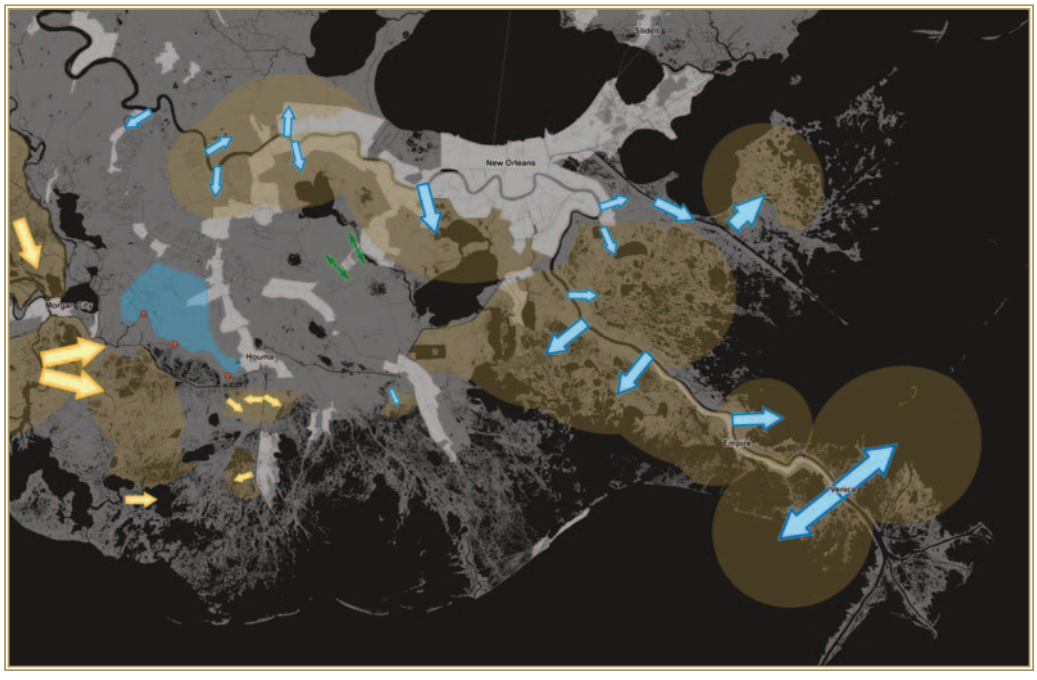
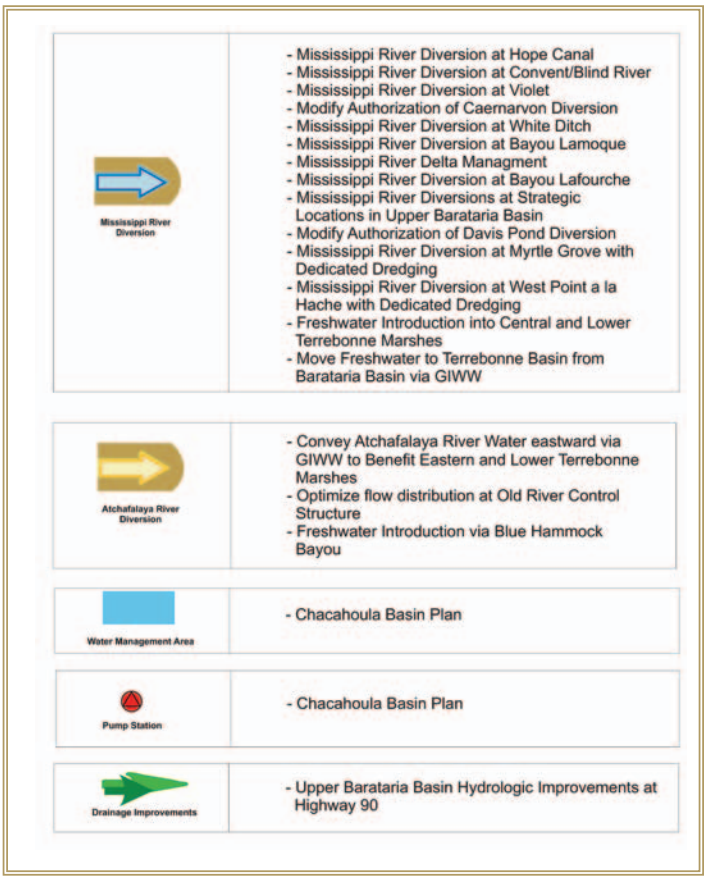


Figure 9: Restoring natural processes in the Delta Plain.

Marsh restoration using dredged material. One way to accelerate the benefits of diversions would be to mechanically restore lost marsh by pumping sediments via pipeline from the bed of the Mississippi River, offshore, or from navigation channels. Combining land sustaining diversions and this type of mechanical marsh restoration could rapidly convert open water to wetlands and help the restored marsh remain viable. Pipeline conveyance of sediment is seen as a particularly good option for areas like Myrtle Grove and West Point a la Hache, where the Master Plan recommends situating land sustaining diversions. Together, diversions and pipeline conveyance of sediment could rebuild marsh quickly in areas where land loss has reached crisis levels.

The Master Plan also proposes marsh restoration projects that are not directly associated with river diversions. Such projects are recommended in Lafourche and Terrebonne Parishes where it is difficult to access river water and sediment for natural land building. In areas like these, using dredged material may be the most viable technique for restoring lost wetlands. If the restored marsh cannot be sustained with river water, the areas will need periodic renourishment, and continued investment in pipeline infrastructure will be necessary.



"…management for sediment accumulation in wetlands is essential to their sustainability. This includes sediment delivered by tidal and meteorological processes as well as by river diversions and pipelines that retain sediments in the coastal system rather than discharging them into deep waters. 'Getting the sediment right' should be a central design principle of the plan."

Review comment by the LCA Science Board, March 2007

Navigation channels. Land sustaining diversions introduce river water and sediment directly into nearby wetlands. But large areas of Louisiana's coast that need water and sediment are not adjacent to major rivers. Theoretically, one way to reach these areas with river water is to reactivate old distributary channels such as Bayou Lafourche and Bayou Terrebonne. Practically speaking, however, dense development along these historic channels makes this option difficult, as it would compromise the integrity of adjacent communities. Another alternative would be to use existing navigation channels as "new distributaries" that could channel water to more remote areas of the coast.

For example, the Gulf Intracoastal Waterway and the Houma Navigation Canal could be used to move fresh water from the Atchafalaya River to marshes in Terrebonne Parish, where there are no other readily available sources of fresh water. Such use of navigation channels increases the potential influence of diversions. To take full advantage of this capacity, the Master Plan suggests stabilizing the banks of navigation channels to prevent them from enlarging further and merging with larger waterbodies. The plan's recommendations for the Mississippi River Gulf Outlet reflect both this stabilization component and the use of the channel to direct fresh water and sediment into nearby marshes (see below).

Barrier shoreline restoration. Barrier shoreline restoration is recommended in the Terrebonne and Barataria Basins because these ecologically important habitats are close enough to marsh and human settlements to diffuse wave energy and storm surge. These areas also provide habitat for migratory birds and threatened and endangered species.

The Chandeleur Islands are a separate case. Analyses indicate that these islands are too far from the mainland to provide significant storm protection function for Louisiana. However, the Chandeleurs represent valuable habitat. The U.S. Department of Interior is evaluating the restoration needs of the Breton Sound National Wildlife Refuge, which includes the Chandeleur Islands. The state will help to define this plan and will evaluate how best to implement the plan once it has been completed.

Ridge habitat restoration. Ridges are natural elevated features that were created by bayous or former distributaries of the Mississippi River. Ridges support woody vegetation that cannot survive at the lower elevations of surrounding wetlands. Such vegetation provides habitat for a variety of

wildlife species, including many threatened neotropical migrant birds. Ridges can also deflect storm surge, particularly during lower energy winter and tropical storms.

Shoreline stabilization. The plan recommends the stabilization of selected shorelines near critical land masses and marsh fringes near flood protection works. Typical stabilization measures include rip-rap or some combination of marsh restoration and rip-rap. In areas with relatively firm soils and low wave energy, marsh terracing projects offer a more natural buffer for eroding shorelines. Other innovative possibilities could involve constructing a living oyster reef that would reduce wave energy in front of a shoreline. Securing these areas will help preserve the boundaries of waterbodies and protect areas such as the Biloxi Marshes, the bay side of Grand Isle, and the Jefferson Parish levee system.

A dredge sprays sediment onto the marsh surface nourishing vegetation.

The Mississippi River Gulf Outlet

The Mississippi River Gulf Outlet (MRGO) was constructed to provide a shorter deep-draft maritime traffic route from the Gulf of Mexico to the Port of New Orleans. However, even before the channel was opened in 1965, citizens and scientists raised concerns about its potential to harm the ecosystem and increase storm damages. The Master Plan calls for the immediate closure of the MRGO to deep draft navigation. Components of the plan include:

- Immediately construct a closure dam at Bayou LaLoutre that will restore the integrity of the Bayou LaLoutre ridge. This will affect both the shallow-draft and deep-draft navigation industries, and a comprehensive closure plan should include mechanisms to mitigate the economic consequences for users that rely on the channel. However, these considerations should not in any way delay the channel's immediate closure. In addition, actions must be taken to avoid increased erosion in nearby waterways should shallow draft and recreational traffic circumvent the closure structure.

- Ensure that the channel remains isolated from Lake Borgne so that the channel may convey fresh water from the Mississippi River to the Biloxi Marshes and other areas of St. Bernard Parish. Without such a freshwater conduit, these marshes will not receive wetland building fresh water and sediment.

- Restore wetlands and swamps in the Central Wetlands and Golden Triangle areas.

- Integrate this MRGO closure plan with overall hurricane protection plans for the New Orleans metropolitan area.

Courtesy U.S. Army Corps of Engineers

The MRGO Closure Plan: Issues to Consider

What does the project accomplish? It will form a barrier that slows incoming storm surge and halts saltwater intrusion. It will also provide a channel for distributing badly needed fresh water and sediment into nearby marshes.

What are the issues involved? When the closure dam is in place, the channel will no longer be used for deep draft navigation, and an alternate route for the Gulf Intracoastal Waterway will be lost. The public is concerned that navigation considerations may slow down closure of the channel.

How can the issues be addressed? The first priority must be to close the MRGO with an appropriately designed closure dam. At the same time, the maritime industry is an economic driver in coastal Louisiana, and the effects of the channel's closure must be mitigated. Buy-outs and relocations of affected deep-draft industries may be useful, and the Inner Harbor Navigation Canal (IHNC) lock should be replaced, as this aging structure is a vital component of the Gulf Intracoastal Waterway. However, local residents and others are concerned that the construction and maintenance of the IHNC project will harm communities already hit hard by the hurricanes of 2005. The Corps is currently reevaluating the IHNC replacement project's environmental impact statement to determine how to better address citizen concerns. Regardless of how the lock issue is resolved, the MRGO should be closed immediately.

What happens if we keep the status quo? The MRGO channel will continue to widen, and the area's wetlands will continue to deteriorate. Loss of wetlands also increases the storm surge risk for nearby communities.

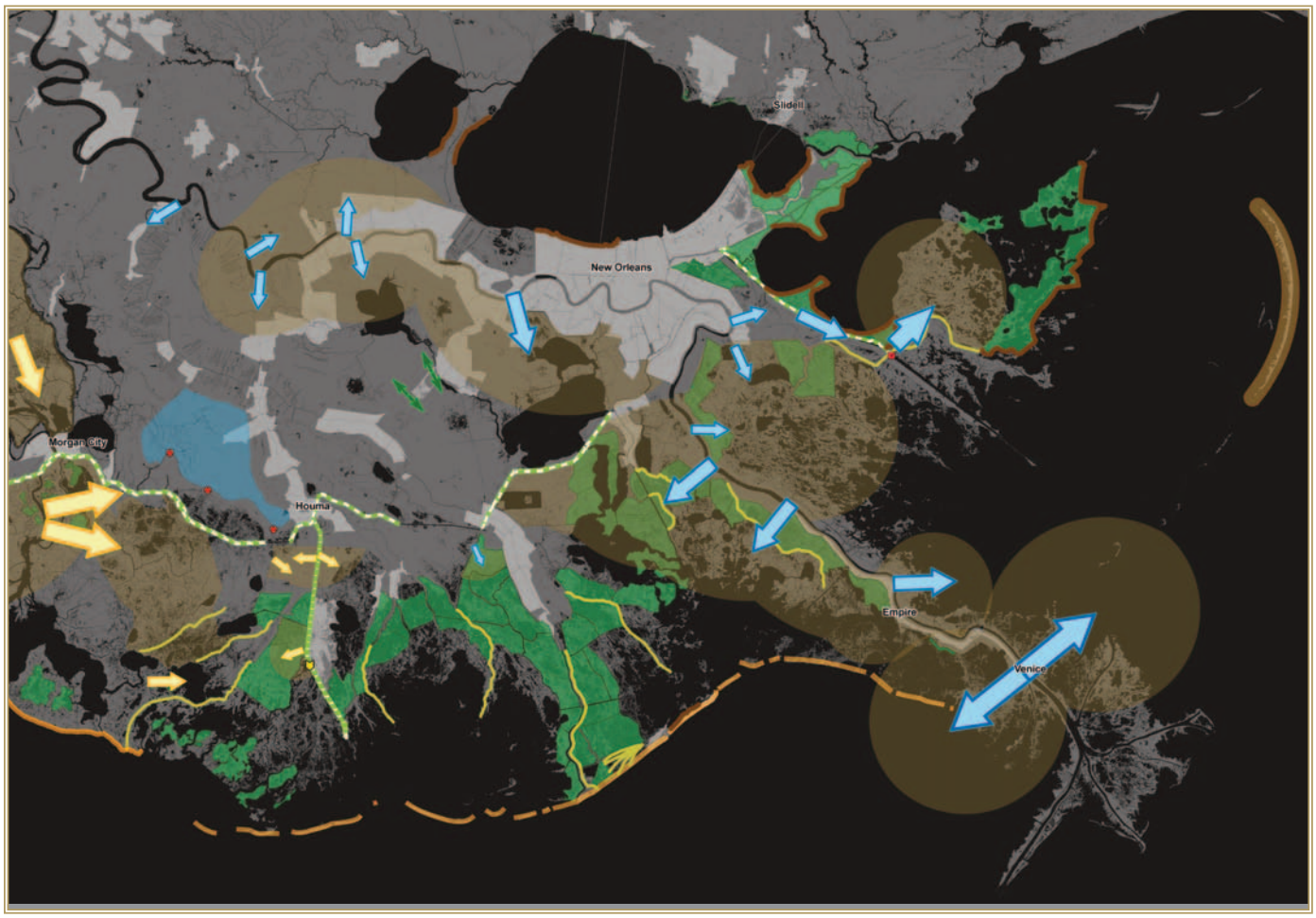


Figure 10: Restoring and maintaining critical landscape features.

Pump Station	- Chacahoula Basin Plan
Closure	- Close Mississippi River Gulf Outlet (MRGO) at Bayou La Loutre Ridge
Drainage Improvements	- Upper Barataria Basin Hydrologic Improvements at Highway 90
Barrier Shoreline Restoration	- Barrier Shoreline Restoration: Chandeleur Islands - Barrier Shoreline Restoration: Barataria Basin - Barrier Shoreline Restoration: Terrebonne Basin - Barrier Shoreline Restoration: Point Au Fer Island
Marsh Restoration using Dredged Material	- Maintain and Restore the Breton Sound Marshes - Maintain and Restore Biloxi Landbridge and Barrier Reefs - St. Tammany Marsh Restoration - Central Wetlands Restoration - Marsh Restoration using Dredged Material at Golden Triangle - East Orleans Landbridge Restoration - Marsh Restoration using Dredged Material in Barataria Basin - Mississippi River Diversion at Myrtle Grove with Dedicated Dredging - Mississippi River Diversion at Point a la Hache with Dedicated Dredging - Marsh Restoration in Terrebonne Basin - Marsh Restoration at Point Au Fer Island - Maintain Landbridge between Caillou Lake and Gulf of Mexico - Beneficial use of Dredged Material
Shoreline Stabilization in Strategic Areas	- East Orleans Landbridge Restoration - Shoreline Protection on South Shore of Lake Pontchartrain - Maintain and Restore Biloxi Landbridge and Barrier Reefs - Maintain MRGO-Lake Borgne Landbridge - Shoreline Stabilization on Maurepas Landbridge - Grand Isle and Vicinity Protection and Shoreline Stabilization
Navigable Waterway Stabilization	- Mississippi River Gulf Outlet (MRGO) Shoreline Stabilization - Bankline Protection for Gulf Intracoastal Waterway (GIWW) - Bankline Protection for Houma Navigation Canal (HNC)
Ridge Habitat Restoration	- Restore Bayou LaLoutre Ridge - Ridge Habitat Restoration in Barataria Basin - Ridge Habitat Restoration in the Terrebonne Basin

Restoring Sustainability to the Atchafalaya River Delta and Chenier Plain

The Atchafalaya River Delta is the only region of coastal Louisiana that is building land naturally, and the Master Plan seeks to take maximum advantage of this resource. Further west in the Chenier Plain, navigation channels and canals have allowed salt water to penetrate inland. This salt water is destroying fragile marsh and impinging on freshwater lakes. Fresh water needed for agriculture is increasingly compromised, a trend that endangers the region's tradition of rice, cattle, and crawfish farming. Groundwater supplies are also being affected as aquifers become saltier. These surface and groundwater resources may cease to provide adequate water for drinking and farming if action is not taken to correct the problem.

In order to fine tune the measures proposed for the Chenier Plain, we must augment our knowledge of how water and sediment enters and flows through the region. Much of this information will be provided by the Chenier Plain Freshwater and Sediment Management and Reallocation planning effort, which is being conducted through the Louisiana Coastal Area Ecosystem Restoration Program.

Managing water and sediment. In order to reduce the impacts of periodic saltwater intrusion, the plan suggests managing river and surface freshwater supplies to allow better maintenance of water sources throughout the year. Such management will also permit the delivery of fresh water to areas that may be exposed to saltwater stress.

Navigation channels. As in the Mississippi River Delta, navigation channels provide opportunities to distribute fresh water from the Atchafalaya River. For example, the GIWW could be used as a conduit to move the river's water to the west where it is badly needed.

Manage inflow of water from uplands. The plan recommends that drainage be wisely managed in the Mermentau Basin. Such management would ensure that fresh water is available for ecosystem and agriculture needs, but that communities are not placed at greater risk of flooding.

Courtesy Bruce Schultz/LSU AgCenter (Hurricane Rita 2005)

Along the coast between Abbeville and the Texas state line, residents' livelihoods are centered on oil and gas, fishing, ecotourism, rice and crawfish farming, and cattle ranching.

Maintain basin integrity of freshwater reservoirs. Inland lakes and freshwater marshes are at continued risk from encroaching salt water. Part of the challenge involves stopping the flow of salt water from Vermilion Bay into inland navigation and irrigation canals. To address this problem, the Master Plan suggests that the banks of selected navigation channels may need to be shored up. This will help prevent further wetland losses and will maintain the channels' capacities to move fresh water and sediment into the system. The plan also recommends fortifying and maintaining spoil banks along the GIWW and Freshwater Bayou Canal to provide another line of storm surge protection.

A second step will involve raising and maintaining critical highways in selected locations so that they can provide three functions: serve as reliable roads before and after emergencies, help maintain the integrity of the Mermentau Lakes Freshwater Basin, and reduce storm surges into interior wetlands. Based on the results of current surge modeling, the plan recommends that sections of LA Highways 82 and 27 be armored and maintained to a height of at least 10 feet where needed (see below "Raising Highways in the Chenier Plain: Issues to Consider.") Highways located on or at the base of cheniers already meet the intent of this criterion and will not need to be raised.

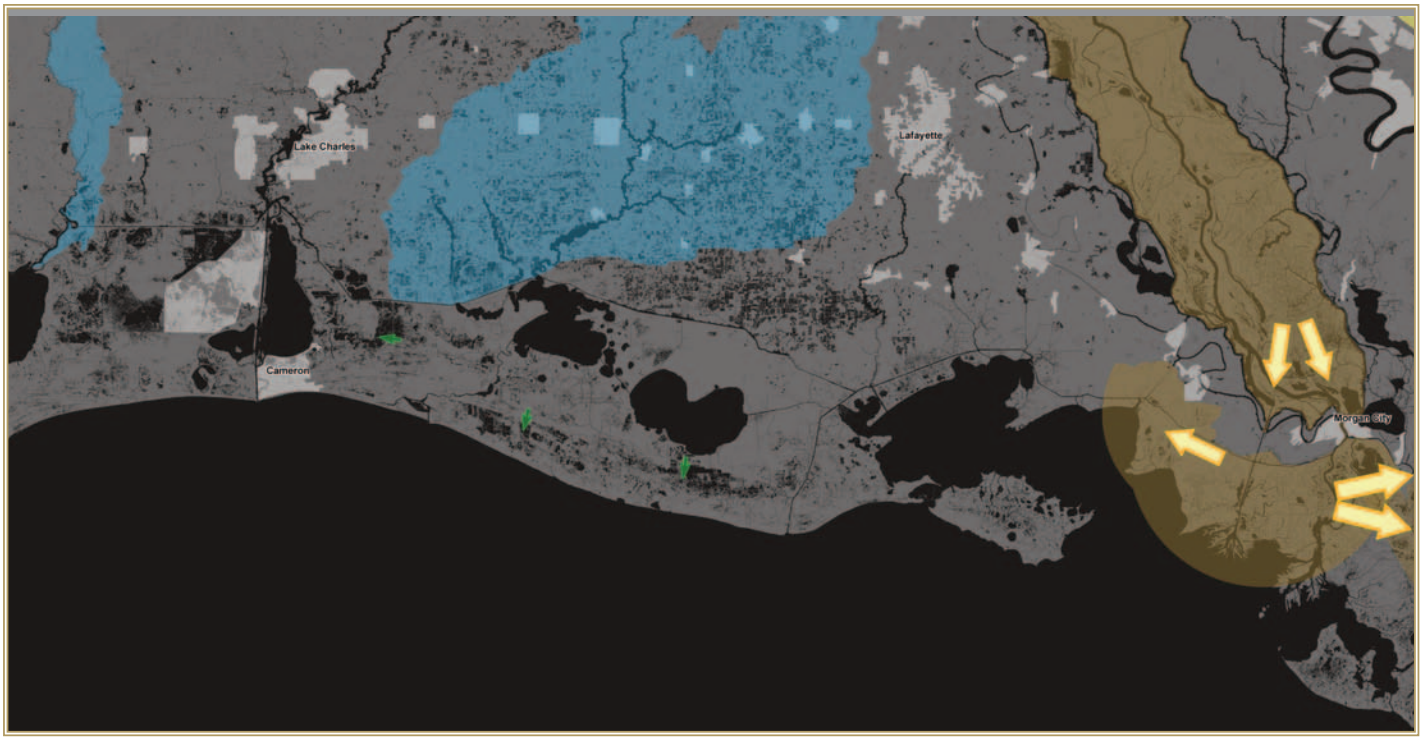


Figure 11: Restoring natural processes in the Atchafalaya River Delta and Chenier Plain.

Atchafalaya River Diversion	- Convey Atchafalaya River Water Eastward via GIWW to benefit Eastern and Lower Terrebonne Marshes - Convey Atchafalaya River Water Westward via GIWW - Freshwater Introduction into Central and Lower Terrebonne Marshes - Increase Sediment Transport Down Wax Lake Outlet - Optimize Flow Distribution at Old River Control Structure
Water Management Area	- Chenier Plain Freshwater and Sediment Managment and Reallocation - Mermentau Basin Watershed Management Plan to Retain Freshwater Resources - Sabine Basin Watershed Managment:
Drainage Improvements	- Hydrologic Improvements in Mermentau Basin at Highways 82 and 27

Courtesy Bruce Schultz/LSU AgCenter

Planting marsh grass to stabilize ICWW shoreline

Managing Freshwater in the Mermentau Basin: Issues to Consider

What does the project accomplish? It will allow continued management of the system and keep fresh water available for users, such as rice, cattle, and crawfish farmers.

What are the issues involved? Managing the basin will require cooperation among the many residents involved. This is particularly true north of the basin where reservoirs for freshwater storage may need to be created, and where the paths of some river channels may need to be restored to more meandering configurations. These options may slow the speed with which water drains from northern communities. At the same time, climate change-induced shifts in rainfall patterns may intensify the problem of salinization and make resolution of these water management challenges more crucial than ever.

How can the issues be addressed? All affected citizens need fresh water and therefore have a direct incentive to use their resources wisely for the advantage of the entire region. There are many tools available for achieving this goal. For example, initiatives such as the Wetlands Reserve Program offer options for compensating landowners who opt to convert farmland to wetlands. Farmers may also take advantage of newly designed and more efficient irrigation systems that reduce water use.

What happens if we keep the status quo? The basin will become saltier, and saltwater intrusion will contaminate soil. Irrigation water from surface systems will become saltier and unusable for agriculture. Increased reliance on groundwater may in turn increase subsidence and salinization of aquifers.

Salinity control in deep draft navigation channels. It is also necessary to control salt water at its source by placing salinity barriers at deep draft shipping channels. Safe and efficient navigation must be maintained when implementing these projects. The barriers would be operated periodically to manage saltwater intrusion events. They may also provide additional storm protection benefits. For example, a saltwater intrusion barrier in the Calcasieu Ship Channel at Cameron could work in conjunction with raised highways to restore the integrity of the chenier systems. Today in the Calcasieu-Sabine Basin, landowners intensively manage and partition their holdings to address salinity problems. The proposed barriers in navigation channels would give these landowners the opportunity to work within a regional framework, instead of having to rely solely on their own individual efforts. Increasing the connectedness of the system in this way will also promote a more productive and resilient ecosystem and should increase fisheries' yields.

Marsh restoration using dredged material. There are no major rivers in the Chenier Plain that can be diverted to create substantial areas of new land. In many cases, therefore, beneficial use of material from maintenance dredging of existing navigation channels represents the best way to restore lost wetlands. This is a particularly viable strategy in areas near the Calcasieu Ship Channel and the Atchafalaya River Navigation Channel. In other areas, material dredged and transported from offshore could be used to recreate lost marsh.

Barrier shoreline restoration. Restoring the barrier shorelines of the Chenier Plain in areas of severe shoreline retreat will be accomplished using a combination of two methods: sand placement and use of hard structures, such as offshore segmented breakwaters. Properly combining these two techniques can slow shoreline retreat rates and allow for tidal exchange between the Gulf of Mexico and the interior marsh. These methods will help ensure that the shoreline maintains its integrity and continues buffering wave energy to protect interior marshes.

Shoreline stabilization. The plan recommends stabilizing key areas along the Chenier Plain's bay and lake shorelines that, if breached, would have catastrophic results for the landscape. By preventing enlargement of lakes and bays, stabilization will also protect surrounding marsh, cheniers, and coastal prairie from wave induced erosion.

Restoring the barrier shorelines of the Chenier Plain in areas of severe shoreline retreat will be accomplished using a combination of two methods: sand placement and use of hard structures, such as offshore segmented breakwaters.

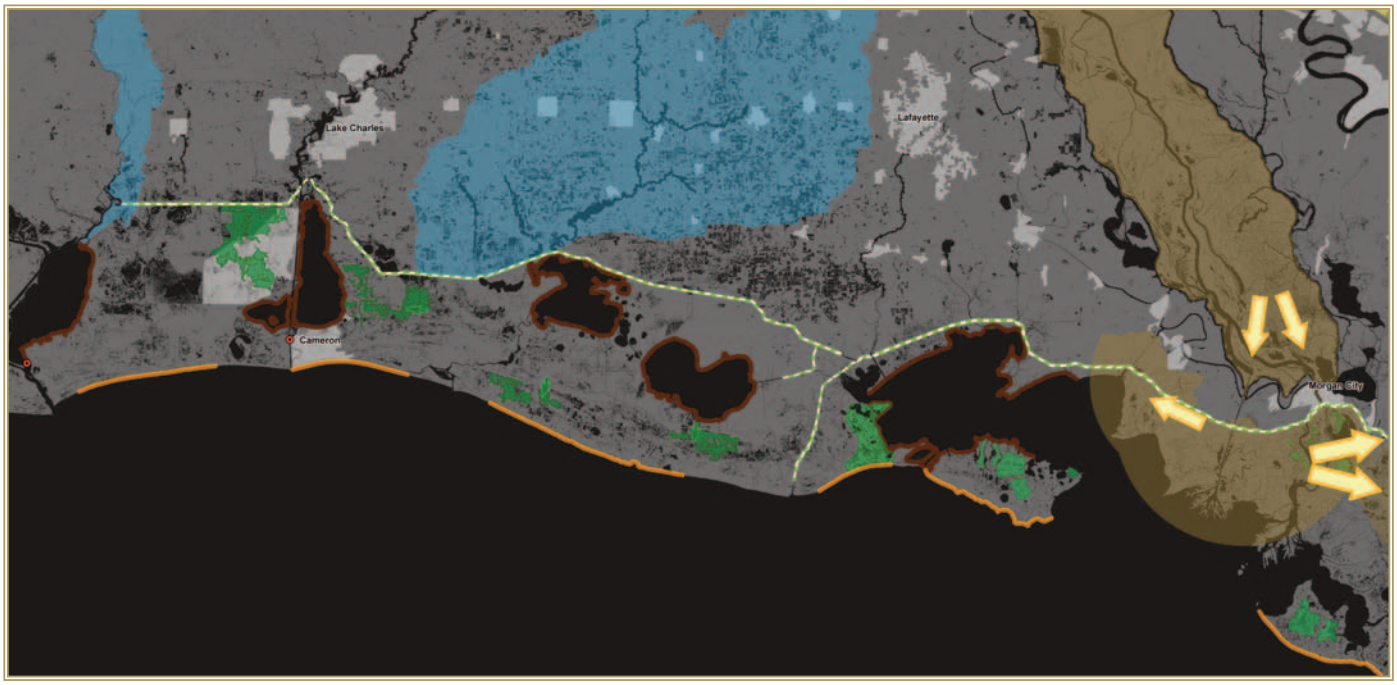


Figure 12: Restoring and maintaining critical landscape features.

 Atchafalaya River Diversion	- Convey Atchafalaya River Water Eastward via GIWW to Benefit Eastern and Lower Terrebonne Marshes - Convey Atchafalaya River Water Westward via GIWW - Freshwater Introduction into Central and Lower Terrebonne Marshes - Increase Sediment Transport Down Wax Lake Outlet - Optimize Flow Distribution at Old River Control Structure
 Water Management Area	- Chenier Plain Freshwater and Sediment Managment and Reallocation - Mermentau Basin Watershed Management Plan to Retain Freshwater Resources - Sabine Basin Watershed Managment
 Salinity Control Structure	- Salinity Control Structure at Calcasieu Pass - Salinity Control Structure at Sabine Pass
 Drainage Improvements	- Hydrologic Improvements in Mermentau Basin at Highways 82 and 27
 Barrier Shoreline Restoration	- Barrier Shoreline Restoration: Point au Fer Island - Barrier Shoreline Restoration: Freshwater Bayou to South Point/Marsh Island - Barrier Shoreline Restoration: Sabine River to Calcasieu River - Barrier Shoreline Restoration: Calcasieu River to Freshwater Bayou
 Marsh Restoration using Dredged Material	- Marsh Restoration using Dredged Material at Point au Fer - Marsh Restoration using Dredged Material at Marsh Island - Marsh Restoration using Dredged Material at Weeks Bay - Raynie Marsh Restoration - Marsh Restoration using Dredged Material South of Highway 82 - Beneficial Use of Dredged Material from Calcasieu Ship Channel - Beneficial Use of Dredged Material
 Shoreline Stabilization in Strategic Areas	- Southwest Pass Shoreline Stabilization - Stabilize Shoreline of Vermilion, East and West Cote Blanche Bays - Stabilize Grand Lake Shoreline - Stabilize White Lake Shoreline - Stabilize Calcasieu Lake Shoreline - Stabilize Sabine Lake Shoreline
 Navigable Waterway Stabilization	- Bankline Stabilization of Freshwater Bayou from Belle Isle Bayou to Freshwater Bayou Canal Lock - Fortify Spoil Banks of GIWW and Freshwater Bayou - Bankline Protection for Gulf Intracoastal Waterway (GIWW) - Bankline Stabilization of Freshwater Bayou - Fortify Spoil Banks of GIWW and Freshwater Bayou

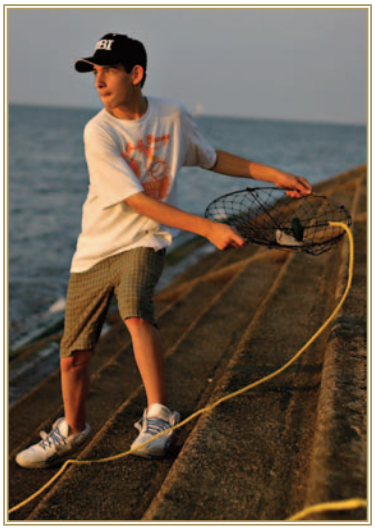
Hurricane Protection

As Hurricanes Katrina and Rita taught us, the residents of south Louisiana need storm protection. Storm surge and economic appraisals have determined that the areas in south Louisiana at risk from a storm surge with a 1% chance of occurring in any given year include 430,000 residences. Possible economic consequences for this level of flooding could top $34 billion. Areas at risk from a storm surge with a greater than 0.2% chance of occurring in any given year include over 870,000 residences. Possible economic consequences for this level of flooding could top $157 billion (see Appendix F).

These figures reflect south Louisiana's geography. Communities situated in the delta plain of the Mississippi, one of the world's major rivers, are at greater risk from flooding than most other places in the U.S. But many of these communities are also integral to the delivery of essential services to the nation, and some, like New Orleans, are unique cultural centers known the world over. These communities could not exist without levees. In recognition of the need for structural protection, hurricane protection structures are recommended in high risk areas that must be protected in order to avoid severe consequences for the state and nation.

However, there is concern that building levees across swamp and marsh can stop the flow of water, leading to further wetland loss and creating impoundments that flood communities. Finding the right mix of options requires that we keep the needs of the entire system in mind.

Consider the entire system. Hurricane protection systems must be built and maintained so that the ecosystem remains dynamic and functional. Water, sediment, and nutrients must be delivered to the wetlands, and overall hydrology must be improved by minimizing impediments to water flow. We must also ensure that protection and restoration actions do not induce flooding in low-lying communities. For example, once a hurricane protection system is built, water flow through wetlands that are landward of these structures must be maintained, and even enhanced where necessary, to maintain water and sediment exchange.



Courtesy Scott Russell Photography

How Communities Can Minimize Their Flooding Risk

- Use smart growth; prohibit development in wetland areas and require buffer zones near levees.
- Communities should strictly enforce National Flood Insurance Program regulations and use appropriate building regulations.
- Consider compartmentalization plans (the Dutch "compartmentation" concept) to contain flooding if levees fail.

In addition, such protection structures should be sited so that they are not exposed to open Gulf conditions. Hurricane protection systems built landward of wetlands are more resilient than stand alone structures because the adjacent marsh and swamp help buffer storm surge and wave energy. An aggressive restoration program, therefore, will protect hurricane protection structures and enhance the protection they offer.

Use non-structural solutions to minimize risks. Hurricane protection systems and restored wetlands cannot eliminate all flooding risks, whether from storm surges, rivers, or rainfall. In addition, wind damage is always a risk for hurricane-prone regions. For these reasons, storm related risks will remain facts of life in south Louisiana, regardless of how many protection structures are built and wetlands are restored. The non-structural solutions described below offer tools that communities can use now to reduce these risks. These solutions should be implemented in all areas of south Louisiana, regardless of whether protection systems are planned or in place.

Smart growth. Wetland areas inside the hurricane protection system need to remain intact and undeveloped. The most state of the art hurricane protection system can actually increase the assets at risk if it encourages development in wetlands or areas near the levee footprint. Such action would not only be risky from a safety and economic standpoint, but it would also degrade wetlands and eliminate interior flood storage capacity. Once a national and state commitment to building a levee is made, local governments must enforce appropriate land use and zoning regulations to ensure that the system, once built, contributes to the long-term sustainability of the region.

Flood insurance. According to FEMA, a home has a 26% chance of being damaged by a flood during the course of a 30 year mortgage, compared to a 9% chance of damage from fire (www.floodsmart.gov/floodsmart/pages/statistics). And because of its low lying topography, Louisiana has the highest rate of repetitive flood losses in the nation. Given the base risk, all residents of coastal Louisiana should purchase flood insurance, even if they live inside a hurricane protection system. Public education about flood risks and the need for insurance is available through the Community Rating System Program.

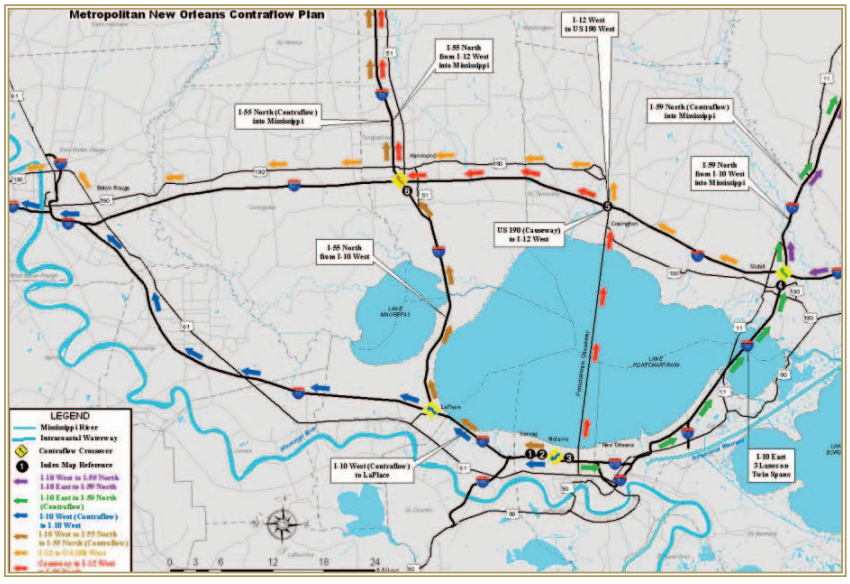
Besides helping residents of coastal Louisiana stay out of harm's way, non-structural measures can reduce insurance costs. For example, the National Flood Insurance Program's Community Rating System lowers flood insurance premiums up to 45% for residents of communities that adopt flood preparedness measures, from floodplain management and buy-out programs to drainage system maintenance. The Community Rating System gives a substantial incentive to communities that zone floodplains with low density uses (Activity 430LZ Low Density Zoning, CRS Coordinator's Manual).

Elevating and retrofitting structures. Residents of south Louisiana must now meet improved building standards to protect against wind damage, and FEMA is formulating guidelines regarding the heights to which homes must be raised in order to avoid damage from storm surge. Hazard mitigation funds are available to citizens through their local parish Emergency Preparedness Offices. These funds can be used to elevate, retrofit, or buy out homes that have suffered damage from flooding (see www.FEMA.gov/fima/hmgp). Adoption of these kinds of measures has the added benefit of lowering flood insurance premiums for homeowners as well as reducing storm damages (FEMA Louisiana Floodplain Management Desk Reference, p. 17-2).

Building codes. In 2007 the state enacted the Louisiana State Uniform Construction Code. This new building code adopted provisions from national and international codes and was designed to ensure that new construction could better withstand hurricane winds. When used in concert with structural elevation, the code will result in substantially safer buildings. The law applies state-wide, with special provisions for areas at particular risk from high winds. All communities must stringently enforce the new code.

FEMA-approved hazard mitigation plans. All 64 Louisiana parishes plus an additional 14 communities received funds from FEMA to develop hazard mitigation plans. Sixty-nine plans have been completed to date. Hurricanes and storms were the main hazards addressed in the plans, which made recommendations for retrofitting critical facilities to make them more disaster resistant. These plans augment the state's own hazard mitigation plan, authorized in April 2005, which spells out priorities for safeguarding critical facilities. The state's plan also emphasizes non-structural measures such as buy-out and elevation recommendations.

Evacuation routes. We need to make sure that evacuation routes are raised where necessary and adequately armored so that residents may safely evacuate and return after a storm passes. The Department of Transportation and Development is working with the Louisiana State Police and the Governor's Office of Homeland Security and Emergency Preparedness to continually improve emergency plans for hurricane evacuation.



Compartmentalization. The plan recommends that metropolitan areas consider a compartmentalization system, similar to the one described for New Orleans by the Bring New Orleans Back Commission. This idea, which is based on the Dutch "compartmentation" concept, goes one step beyond establishing primary lines of defense against storm surge by creating contingencies in the event that some element of the flood protection system is compromised. Just as water-tight compartments enable cruise ships to stay afloat if the outer hull is breached, creating inner protection zones that are hydrologically disconnected from each other can stop a levee failure from inundating an entire metropolitan area. Such a plan must be developed in conjunction with local drainage and land use plans.

Focused structural solutions. Restoration and non-structural measures can reduce the risk from storm surge. But in most areas, the risk of storm surge flooding will remain unacceptably high, even after restoration and non-structural measures are factored in. To more fully protect these high risk areas, hurricane protection structures are recommended in order to provide more protection.

The planning team evaluated several factors as they defined targeted hurricane protection levels for the Master Plan. Population concentrations; the number of strategic assets such as ports, refineries, military installations and others; and the expected costs for disaster response and recovery in specific areas were all considered. The landscape's elevation in relation to the height of potential storm surges was used to compute potential damages that could result from two scenarios: a storm surge that has a 1% chance of occurring in any given year and a storm surge that has a 0.2% chance of occurring in any given year. These storm scenarios were used when the Master Plan was prepared because they incorporated the best and most up-to-date data available. Ongoing storm surge, economic, environmental, and engineering analyses will ultimately define the standard of protection that is achievable for all of Louisiana's coastal communities.

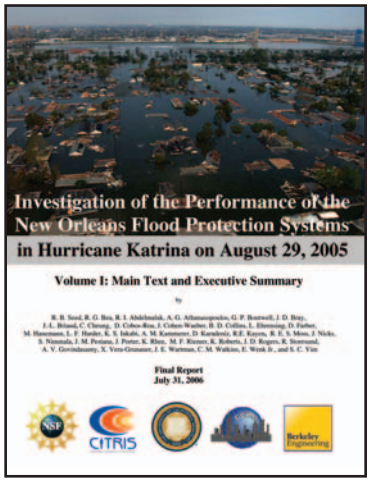
From these analyses, the major urban areas of the coast—the New Orleans, Houma, Lafayette, and Lake Charles regions—were identified

as needing very high levels of protection. Scaling the level of protection to the population and infrastructure at risk is the best way to build a case for the major federal appropriations that will be needed to get the job done. Smaller communities will not necessarily receive this higher level of protection. In many of these smaller communities, non-structural solutions (see above) will reduce risks more quickly than will massive building projects that take years to be constructed.

After decades of building hurricane protection systems, we have learned many things about the best ways to proceed. Among these considerations are the following:

- Barriers redirect but do not eliminate storm surges, so the system must build in room for storm surge water to move.
- Controlled overtopping can be acceptable if there is sufficient space for temporary water storage within the protection system. All structures must be designed so that they do not breach if over topped.
- Hurricane protection systems must be designed to ensure that interior flooding will not occur from extreme rainfall events. Drainage structures, pumps, and adequate internal water storage capacity are necessary.
- Longer, more complex protection systems must include more structures to accommodate drainage, pipelines, railroad crossings, and other features. This increases the potential locations of structural failures.
- By changing the way water flows, structures can help divert water and sediment to critically stressed wetland areas.
- Unarmored earthen levees are not appropriate in all environments. Innovative technologies are needed if hurricane protection structures are placed in high energy environments or in areas with extremely soft soils. This will increase reliability and reduce maintenance requirements.

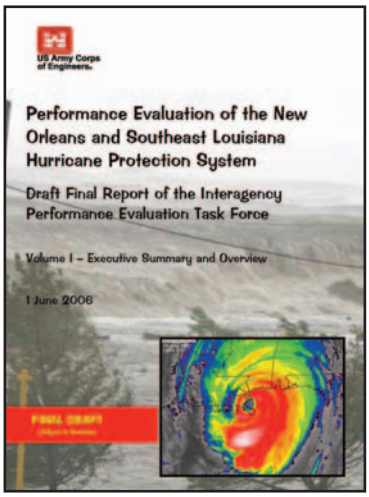
Unarmored earthen levees are not appropriate in all environments. Innovative technologies are needed if hurricane protection structures are placed in high energy environments or in areas with extremely soft soils. This will increase reliability and reduce maintenance requirements.



- We must get the movement of water and sediment right. At risk are the health of wetlands, the viability of a diverse ecosystem, and the safety of communities.

- Unwise development in flood-prone areas must be strictly discouraged through enforcement of land use regulations.

- All hurricane protection structures must be designed to provide adequate and reliable protection to communities; complement ecosystem restoration measures; minimize disruptions to tides and water flow; and, if overtopped, remain functional and allow quick drainage of water from the system.



Recent reviews of the performance of the New Orleans hurricane protection system by the American Society of Civil Engineers, Team Louisiana, and the Interagency Performance Evaluation Task Force have also made detailed recommendations for improving future designs. The state will continue to work with the Corps of Engineers, levee districts, and parishes to make sure that the construction of hurricane protection structures is compatible with wetland restoration.

Because these issues are still under study, the exact placements of many hurricane protection structures are not final, and will be determined as feasibility studies are completed. The maps in the following sections explain some of the issues in play.

New Orleans metropolitan area. When complete, repairs to the area's hurricane protection projects will not provide enough protection to the New Orleans metropolitan area, and they cannot be retrofitted to substantially increase protection beyond the 100 year level without major impacts to the community. In addition, the North Shore of Lake Pontchartrain and other areas surrounding the lakes have no protection from storm surges entering from the Gulf. To address these deficiencies, an outer barrier must be built to work in tandem with projects already on the ground or being planned. For the purposes of this plan, we used the Corps' projection that it would complete all authorized and funded hurricane protection system upgrades in metropolitan New Orleans by 2010.

What is the "funnel effect?"

A funnel effect is created when two levees come together at an angle. At these junctions, storm surge is magnified, and forces acting upon the levees are increased. Under certain circumstances, as occurred at the junction of the MRGO with the GIWW during Hurricane Katrina, a funnel effect can overwhelm flood protection systems. Although it is best to engineer the flood protection systems to minimize the funnel effect, levees can be raised and strengthened to accommodate an anticipated increase in flood heights. There are also opportunities to use the funnel effect to our advantage, directing water to engineered spillways that will allow overtopping into storm surge reservoirs. This advantage can best be utilized when constructing outer barriers near areas that can store significant amounts of water, such as Lake Pontchartrain.

Different alignments for this project will have different effects (see three possible concepts next page), but overall, the project will be designed to minimize impacts to both the habitat of important species and hydrology in and around Lakes Pontchartrain and Borgne. If not designed to work with existing hurricane protection systems, the project's design may worsen flooding from hurricanes in nearby areas such as St. Bernard Parish and Mississippi. For these reasons, the state must continue modeling efforts to determine the optimal alignment. Such an alignment will provide the necessary hurricane protection while balancing all four of the Master Plan's objectives. If the results of this research show that higher surge levels will be created for some areas, existing levee systems will need to be raised or strengthened.

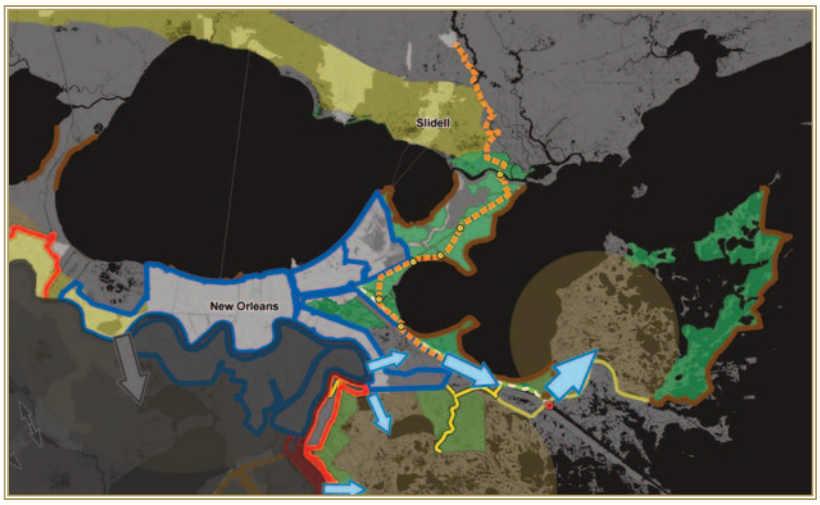


Figure 13. Lake Pontchartrain Barrier Alignment: #1-Interior at Golden Triangle.

Alignments #1 and #2 are fairly similar, although #1 would not enclose the Golden Triangle and would thus have the least direct ecosystem impact. However, without proper design Alignment #1 could change water flow and restrict animal and boat access through major channels. Of the three conceptual alignments, this one does the least to address the existing funnel effect and provides no water storage landward of the levee.

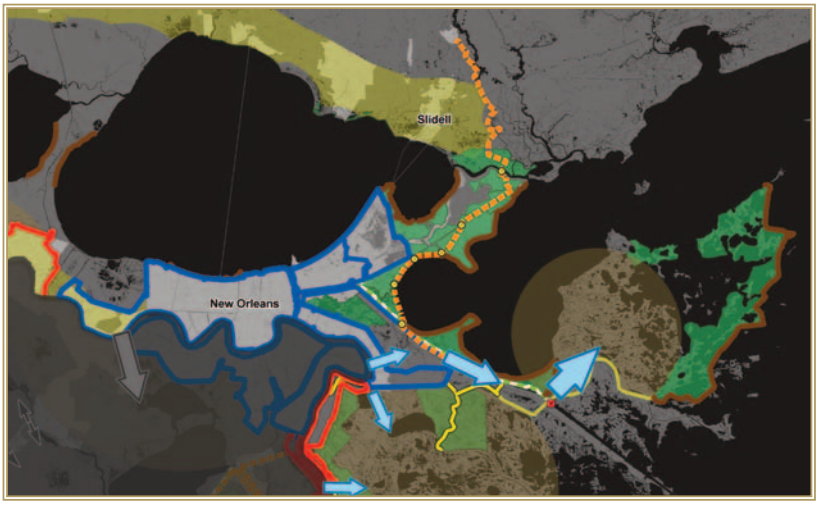


Figure 14. Lake Pontchartrain Barrier Alignment: #2-Rim of Lake Borgne.

Unlike Alignment #1, this alignment would enclose the Golden Triangle, and would thus have a greater ecosystem impact. In addition, without proper design, Alignment #2 could change water flow and restrict animal and boat access through major channels. Impacts to the habitat of the Gulf Sturgeon, a threatened species, would also need to be addressed. Alignment #2 would reduce the funnel effect; further modeling will reveal the extent of this reduction.

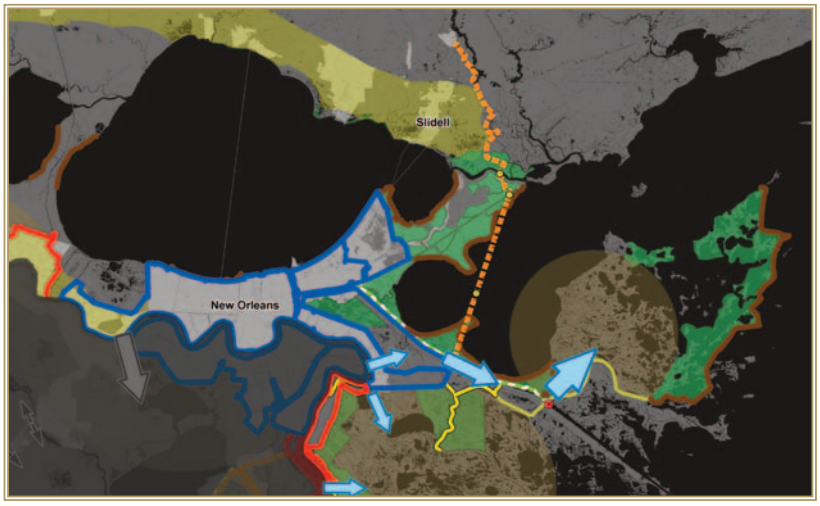
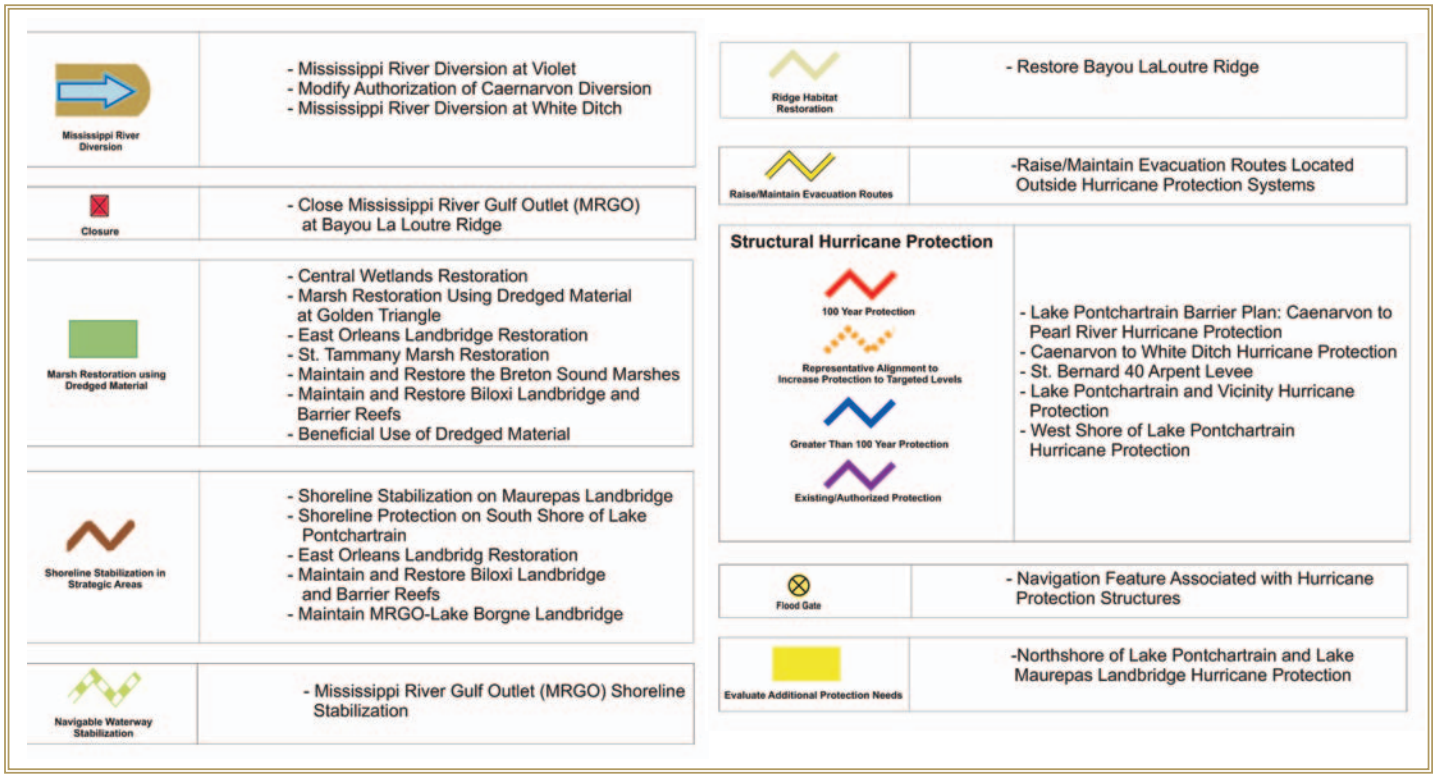


Figure 15. Lake Pontchartrain Barrier Alignment: #3-Lake Borgne.

This alignment may provide the most reliable protection against storm surge because it eliminates the funnel effect and provides water storage to accommodate overtopping. However, it could be the most challenging of the three alignments to build because it would be situated in the open water of Lake Borgne. This alignment would also pose the greatest challenges for maintaining ecosystem function, including maintaining adequate water exchange and animal movement. Issues related to the Gulf Sturgeon, a threatened species, would also need to be addressed. Innovative storm barrier concepts, such as pile-supported concrete structures, could be used to increase the feasibility of this alignment.



The following actions are needed in order for the New Orleans metro area to achieve more than a 1% level of protection, meaning protection over the level needed to withstand a storm with a 1% chance of occurring in any given year: (1) raise existing levees to the 1% level of protection through ongoing work by the Corps of Engineers, and (2) build an outer barrier (see alternatives).

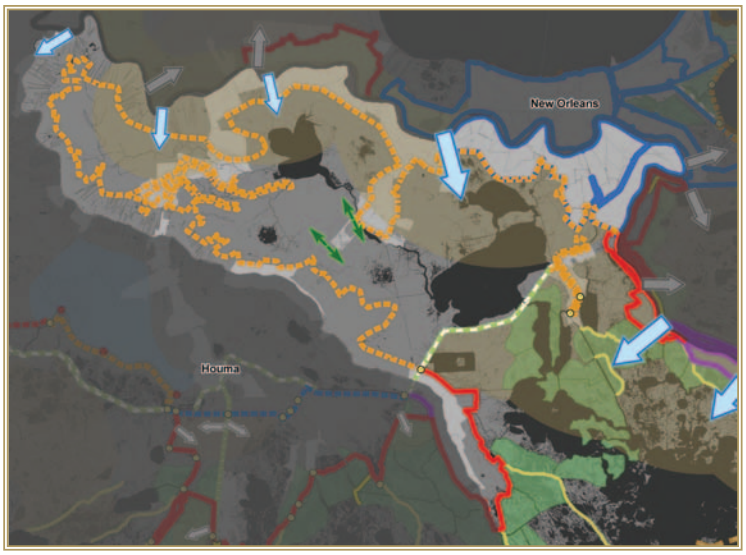


Figure 16. Donaldsonville to the Gulf Alignment: #1- Swamp.

This alignment follows the upland margin of the Barataria Basin wetlands. If a traditional earthen levee were used, this alignment would minimize further disruptions to the basin hydrology. However, the length of this alignment would increase construction, operation, and maintenance costs, as well as the number of structures needed for drainage, pipeline, and water channel crossings. As a result, this alignment includes more potential locations for structural failure. In addition, this alignment provides no water storage landward of the levee. If the structure were overtopped, water would flow into populated areas. The West Bank and Vicinity project levees would also need to be raised beyond the level provided by the Corps's ongoing work, in order to achieve a greater than 1% level of protection for the West Bank of metro New Orleans. There are questions as to how feasible it would be to raise these levees—both technically and economically. Ring levees would need to be added around central basin communities, including Chackbay, Kraemer, Crown Point, Jean Lafitte, and Lafitte to provide a 1% level of protection for these communities.

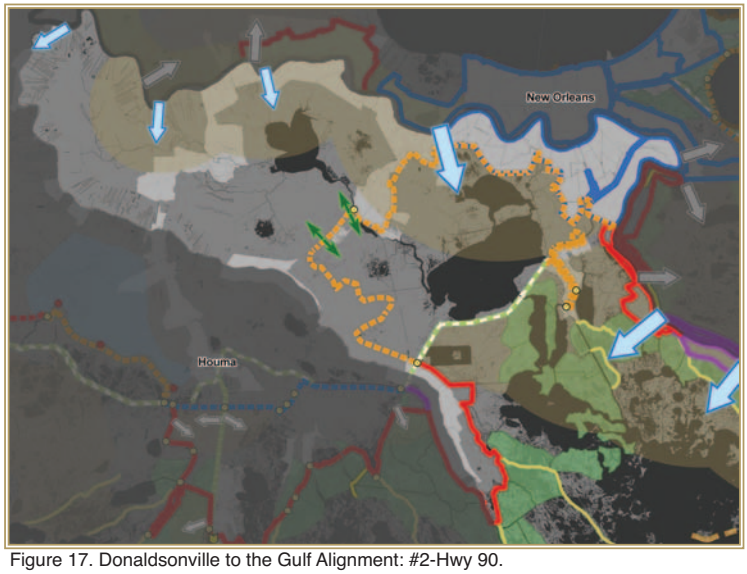


Figure 17. Donaldsonville to the Gulf Alignment: #2-Hwy 90.

Because it would be built near Highway 90, an existing hydrologic barrier in the basin, this alignment would minimize further disruptions to water flow patterns. In fact, when coupled with needed drainage improvements under Highway 90, this alignment could improve water exchange throughout the basin. Its shorter length would reduce construction, operations, and maintenance costs, and it would require fewer water channel, pipeline, drainage and other ancillary structures. As a result, this alignment would have fewer potential locations for structural failure. However, this alignment would still have direct impacts on wetlands. In addition, if this alignment were built, the West Bank and Vicinity project levees would need to be raised beyond the level provided by the Corps's ongoing work, in order to achieve a greater than 1% level of protection for the West Bank of metro New Orleans. There are questions as to how feasible it would be to raise these levees—both technically and economically. A ring levee would also have to be built around Crown Point, Jean Lafitte, and Lafitte to provide a 1% level of protection to these communities.

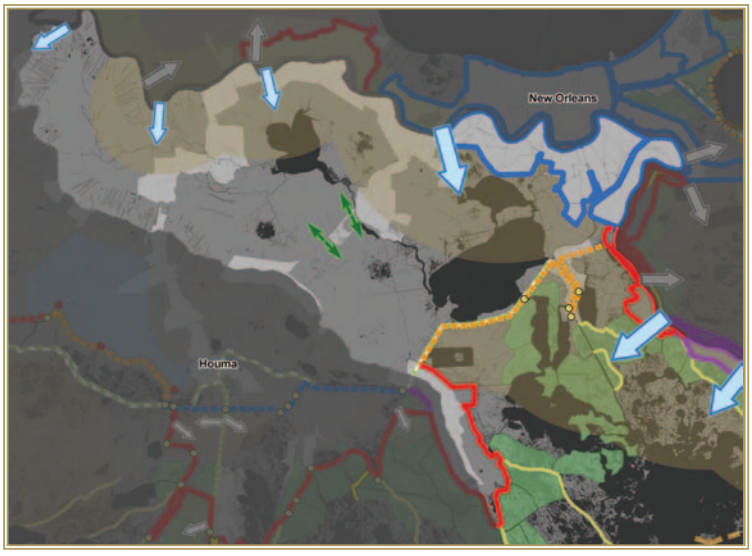
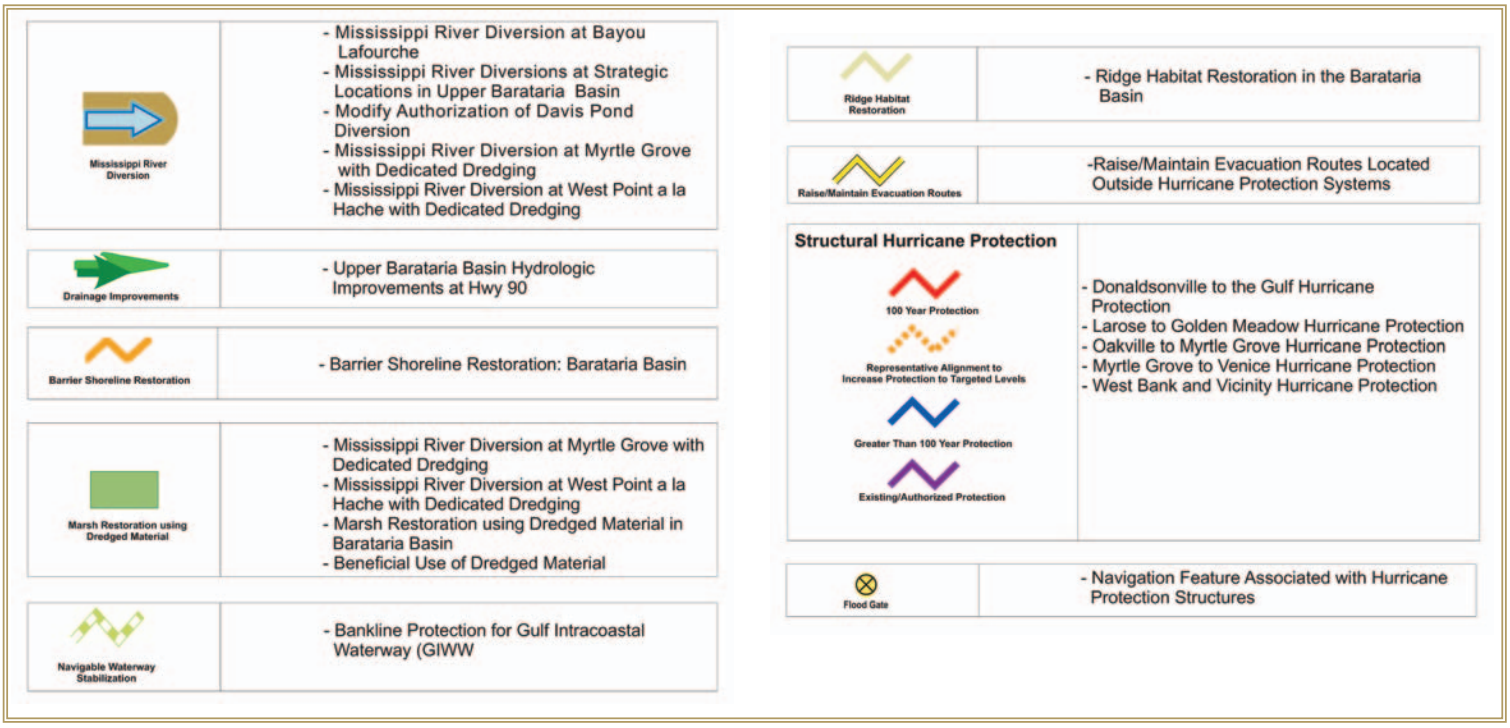


Figure 18. Donaldsonville to the Gulf Alignment: #3-GIWW.

This alignment would follow the Gulf Intracoastal Water Way roughly between Oakville in Plaquemines Parish and LaRose in Lafourche Parish. It would provide space for temporary water storage should overtopping occur, and it could be designed to help direct water to areas such as eastern Terrebonne Parish, which would otherwise be difficult to reach using river diversions. It would also protect central Basin communities, including Crown Point, Jean Lafitte, and Lafitte. However, if it were not properly designed to increase wetland sustainability in conjunction with necessary restoration projects, this alignment would further stress ecosystems that support commercially and recreationally important fish and wildlife species in Barataria Basin. Innovative designs and technologies will need to be used to ensure the sustainability of the basin's wetlands, improve reliability of the protection structure, and reduce maintenance costs.

Barataria Basin and West Bank. Lafourche Parish communities north of LaRose as well as central Barataria Basin communities are unprotected from storm surges. In addition, when an authorized protection project entitled "West Bank and Vicinity" is completed, the West Bank of New Orleans will still remain unacceptably vulnerable to surge from very large storms. The Master Plan recommends that protection be provided to Lafourche and central basin communities, such as Lafitte, at the level that could withstand a storm with a 1% chance of occurring in any given year. The Master Plan further recommends that the West Bank's protection be improved over this level. Further analyses must be performed to define the exact placement and height of this protection. In all instances it is important to improve drainage through the Highway 90 roadway embankment to help restore upper basin swamps. All of these issues are being evaluated as part of the Corps of Engineers' Donaldsonville to the Gulf feasibility study. Figures 16-18 present options now under study.



The following actions are needed in order for West Bank and Vicinity of metro New Orleans to achieve more than a 1% level of protection, meaning protection over the level needed to withstand a storm with a 1% chance of occurring in any given year: (1) raise existing levees to the 1% level of protection through ongoing work by the Corps of Engineers, and either (2) raise the West Bank and Vicinity levees further, or (3) build an outer barrier (see alternative 3).

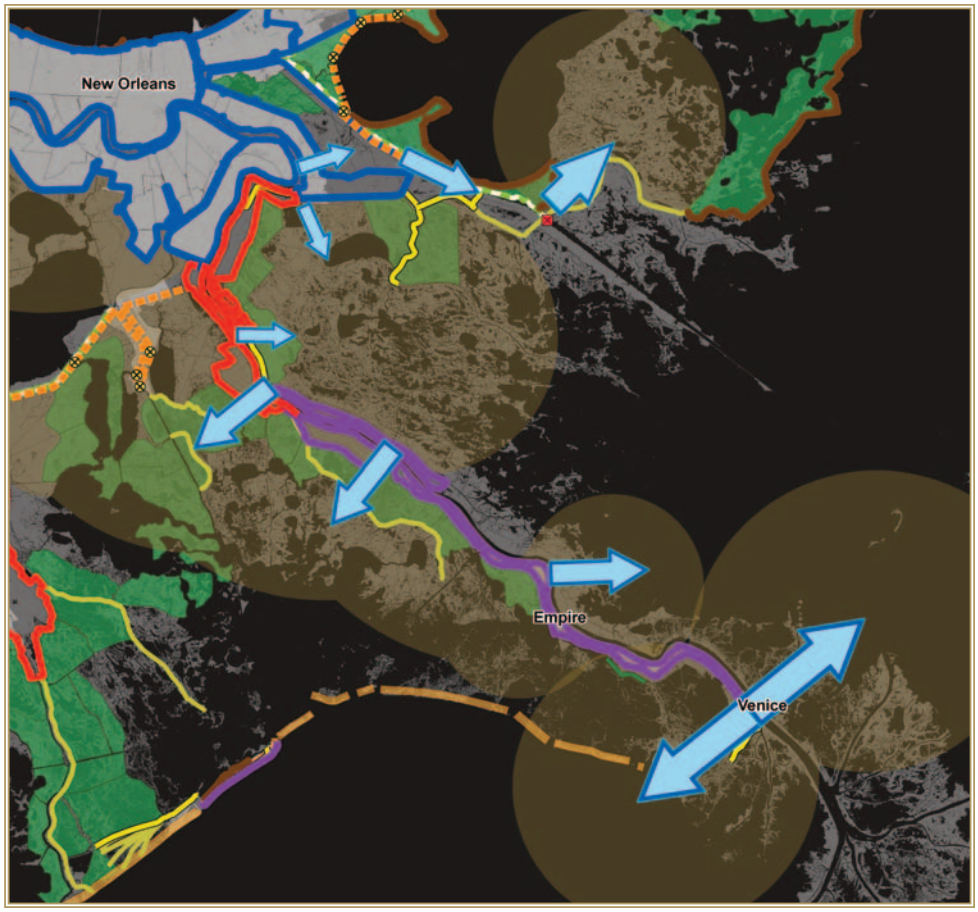
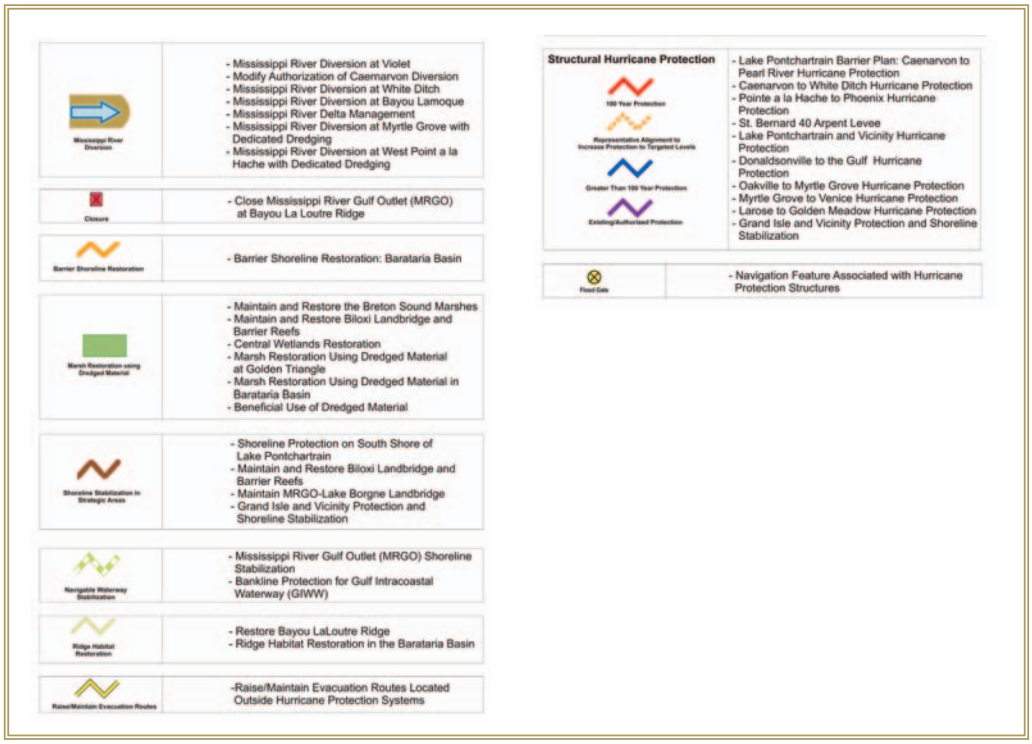


Figure 19. Proposed hurricane protection in Plaquemines Parish.



Plaquemines Parish. The plan recommends a multi-faceted protection plan for Plaquemines Parish.

1. From the upper portions of the parish down to Oakville on the west bank of the Mississippi River, the plan recommends a hurricane protection system that would provide a greater than 100 year level of protection, meaning protection over the level needed to withstand a storm that has a 1% chance of occurring in any given year.

2. From Oakville to Myrtle Grove on the west bank and from Caernarvon to White Ditch on the east bank (areas that include the ConocoPhillips refinery at Alliance), the plan recommends improving the current levee to provide a level of protection that would protect against a storm with a 1% chance of occurring in any given year. These stretches of levee should be raised and be made a part of the federal hurricane protection system.

3. The drainage levee south of Myrtle Grove should be federalized and brought to the same elevation as the current federal hurricane protection levees in southern Plaquemines Parish.

4. South of St. Jude on the west bank and south of Phoenix on the east bank, the levees would be maintained at their currently authorized heights.

5. Maximize use of non-structural measures.

This decision reflects several constraints. The levee system in lower Plaquemines Parish is very long, and the entire region is steadily subsiding. Because it is surrounded by deep Gulf waters, this levee system is also subject to relatively high wave energy and storm surge levels. For these reasons, it would be very challenging to increase levee heights in lower Plaquemines Parish, to fortify them so they remain functional if overtopped, and to maintain them at their authorized elevations.

ConocoPhillips refinery at Alliance in Plaquemines Parish seen from across the Mississippi River.

Hurricane Protection in Plaquemines Parish: Issues to Consider

What does the project accomplish? The proposed hurricane protection system would upgrade levels of protection and protect key assets of the parish. Non-structural solutions would work in conjunction with the levees to reduce risk.

What are the issues involved? While it would retain the level of hurricane protection it has now, lower Plaquemines Parish south of St. Jude and Phoenix would not receive enhanced structural hurricane protection. There is concern that this strategy would isolate lower Plaquemines Parish, prevent residents and business owners from obtaining affordable insurance, and undermine the parish's economy.

How can the issues be addressed? The Coastal Protection and Restoration Authority, including the Departments of Insurance and Economic Development, will work with Plaquemines Parish government to address these concerns, recognizing the unique constraints and opportunities in this coastal region. The Master Plan's proposed barrier island restoration measures and the Mississippi River Delta Management plan will, over time, increase protection to citizens of Plaquemines Parish. In the lower regions of the parish, hurricane protection will have to encompass a range of strategies, including raising homes and other non-structural improvements made by individual homeowners. In keeping with this approach, residents of lower Plaquemines Parish, along with other south Louisiana residents who live in vulnerable areas, are advised not to rebuild their homes at grade on slabs.

What happens if we keep the status quo? Plaquemines Parish will be unacceptably vulnerable to storm surge without the proposed improvements to the hurricane protection system and the adoption of other non-structural solutions.

Courtesy Scott Russell Photography

Terrebonne Parish and Atchafalaya Delta. Terrebonne Parish is experiencing the highest rate of land loss in coastal Louisiana, and communities in the lower parish are often flooded from extreme high tides and small storms. This means that the Houma/Thibodaux metro area's 200,000 residents are currently unprotected. Wetland restoration alone cannot do the job; storm surge barriers are also needed. For this reason, the plan recommends that the existing alignment for the Morganza to the Gulf project be constructed. This project has been vetted and approved after more than 15 years of review by citizens at public meetings and by scientists and engineers who have conducted numerous feasibility studies. The project has also been reviewed through the National Environmental Policy Act (NEPA) process, which assesses the environmental impact of major federal projects.

The oil and gas drilling platforms and the legs that will hold them up above the water's surface are fabricated inland and then floated out to deepwater sites and placed into position.

Having passed muster in all of these arenas, the project has been awaiting authorization for the past six years as part of a federal Water Resources Development Act. Because this project is so critical to the future of Houma and surrounding communities, the Terrebonne Levee and Conservation District is using local funds to construct portions of the levee.

There are concerns that if land use practices are not changed to require buffer zones near the levee and prohibit development in wetlands, the levee could encourage new development in low-lying areas and increase the assets at risk. These consequences would run counter to the Master Plan's objectives of sustaining wetlands and reducing risks to coastal communities.

The project's alignment follows spoil banks and canals in order to minimize effects on wetlands. Environmental structures are incorporated into this alignment to restore connections of impounded wetlands to the estuary. Certain portions of the alignment will have to be carefully designed to take advantage of lessons learned during Hurricane Katrina regarding the best way to handle storm surge. This presents an opportunity to explore new technology and innovative concepts. Figures 20 and 21 show alternatives being considered for the design phase of this aspect of the project.

If we do not build Morganza to the Gulf, residents in Dulac, Chauvin, and Montegut will be forced to move inland. Houma, one of the region's centers of oil and gas industry, will remain at unacceptable risk from even small hurricanes. Wetlands near the proposed project that are already impounded from spoil banks and canals will continue to deteriorate unless environmental structures are built to restore connections to the estuary.

In addition to the Morganza to the Gulf project, an interior levee system may also be needed in order to provide adequate levels of protection to the Houma/Thibodaux area. The need for this additional barrier will be assessed as the Morganza project moves toward completion, but it must not slow progress toward construction of the existing alignment.

LA 1 Highway Corridor. Louisiana's southernmost port is Port Fourchon, strategically located in the central Gulf region where it serves as a focal point for deepwater oil and gas activities. However, the only roadway connecting the port to the rest of the nation is the vulnerable, two-lane LA 1 highway. Efforts are underway to upgrade and raise on concrete structure the sections of LA 1 that are outside of the existing levee system. To protect the portion of this federally recognized energy corridor that lies within the levee system, the levee between LaRose and Golden Meadow should be raised significantly to provide a 1% level of protection. This means that the protection would be sufficient to withstand a storm with a 1% chance of occurring in any given year. Completion of the Morganza to the Gulf and Donaldsonville to the Gulf projects, together with restoration activities, would further increase levels of protection to this highway. If further modeling and analysis show that risks to assets in this area remain unacceptably high, the Master Plan recommendations will be modified accordingly.

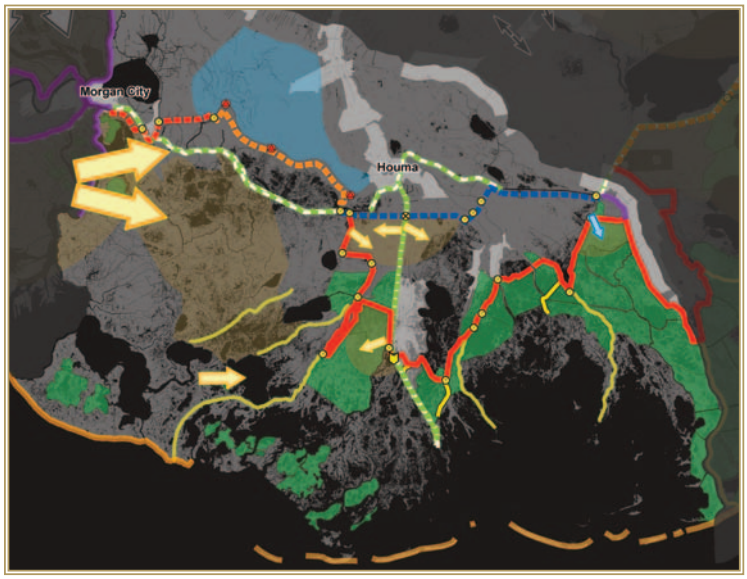


Figure 20. Morganza to the Gulf Alignment: Project Awaiting Authorization.

This alignment follows existing ridges wherever possible and incorporates floodgates and water control structures to mimic natural water flow patterns. The need to maximize protection to coastal communities was balanced with the need to make allowances for sediment and water flow. In many cases, these measures could improve water exchange through wetlands. Throughout the 15 years that this project has been developed, there has been active stakeholder and public input.

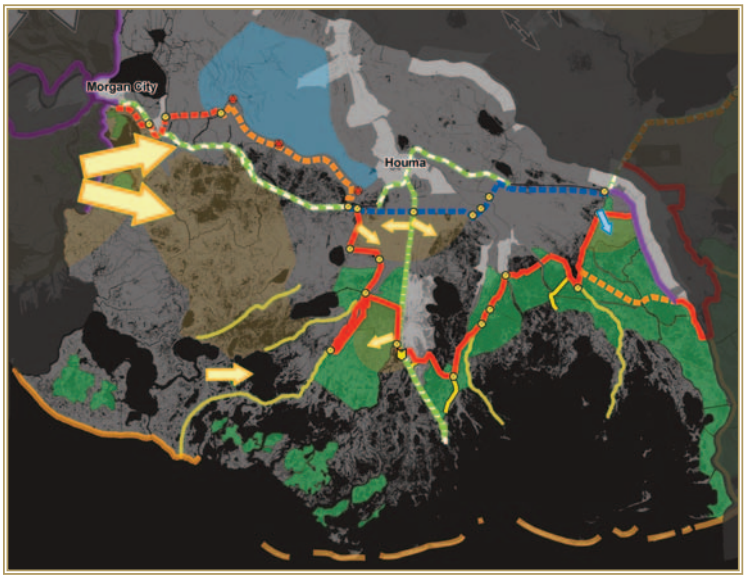


Figure 21. Morganza to the Gulf Alignment Addition: Pointe au Chien to Golden Meadow.

This additional alignment would extend from Pointe au Chien to Golden Meadow and would reduce the funnel effect created where the proposed Morganza to the Gulf Alignment meets the LaRose to Golden Meadow levee. The additional alignment would also increase protection to lower Lafourche communities. However, if not properly designed to allow for adequate water movement, this addition could further stress the area's fragile wetlands. As a result, this addition would have to incorporate floodgates and work in tandem with water and sediment diversions to ensure that water exchange contributes to wetlands sustainability. Resolution of these issues must not delay the implementation of the current Morganza to the Gulf Alignment, which is being considered for federal authorization.

The current Morganza to the Gulf alignment should be constructed to provide a 1% level of protection to communities such as Dulac, Montegut, and Chauvin, as well as larger communities to the north. To provide the Houma/Thibodaux area with a greater than 1% level of protection, meaning protection over the level needed to withstand a storm with a 1% chance of occurring in any given year, the following actions are needed: (1) either raise the Morganza to the Gulf levee further, or (2) build an inner barrrier.

Mississippi River Diversion	- Move Freshwater to Terrebonne Basin from Barataria Basin via GIWW
Atchafalaya River Diversion	- Freshwater Introduction via Blue Hammock Bayou - Convey Atchafalaya River Water Eastward via GIWW to Benefit Eastern and Lower Terrebonne Marshes - Freshwater Introduction to Central and Lower Terrebonne Marshes
Water Management Area	-Chacahoula Basin Plan
Pump Station	- Chacahoula Basin Plan
Lock	-Multipurpose Operation of the Houma Navigation Canal (HNC) Lock
Barrier Shoreline Restoration	- Barrier Shoreline Restoration: Terrebonne Basin - Barrier Shoreline Restoration: Point Au Fer Island
Marsh Restoration using Dredged Material	- Marsh Restoration Using Dredged Material in Terrebonne Basin - Maintain Landbridge between Caillou Lake and Gulf of Mexico - Marsh Restoration Using Dredged Material at Point Au Fer - Beneficial Use of Dredged Material
Navigable Waterway Stabilization	- Bankline Protection for Houma Navigation Canal - Bankline Protection for Gulf Intracoastal Waterway (GIWW)
Ridge Habitat Restoration	- Ridge Habitat Restoration in the Terrebonne Basin
Raise/Maintain Evacuation Routes	-Raise/Maintain Evacuation Routes Located Outside Hurricane Protection Systems
Structural Hurricane Protection 100 Year Protection Representative Alignment to Increase Protection to Targeted Levels Greater Than 100 Year Protection Existing/Authorized Protection	- Morganza to the Gulf Hurricane Protection - Houma and Vicinity Hurricane Protection - Morgan City to Gibson Hurricane Protection -Gibson to Houma Hurricane Protection - LaRose to Golden Meadow Hurricane Protection
Flood Gate	- Navigation Feature Associated with Hurricane Protection Structures

Acadiana. In this region, the highest concentrations of assets are found in Lafayette, New Iberia, and Abbeville. The plan recommends that these areas receive a greater than 100 year level of protection, meaning protection over the level needed to withstand a storm that has a 1% chance of occurring in any given year. Areas between New Iberia and Berwick/Patterson should receive a 100 year level of protection. However, more modeling and analysis need to be done to determine appropriate protection measures for this area.

Chenier Plain. The plan recommends that the Lake Charles/Sulphur area receive a greater than 100 year level of protection, meaning protection over the level needed to withstand a storm that has a 1% chance of occurring in any given year. This could be achieved with a ring levee that surrounds the population centers as well as critical oil and gas infrastructure. More modeling and analysis need to be done to properly evaluate the vulnerability of this area and to define the needed flood protection alignments.

Areas between Abbeville and Lake Charles, where the human population is large but dispersed, would initially be protected by the raised highways and fortified spoil banks previously described. If further modeling and analysis show that these measures will not provide protection from a storm that has a 1% chance of occurring in any given year, a levee would be considered along the GIWW. This analysis is still ongoing.

Courtesy Bruce Schultz/LSU AgCenter

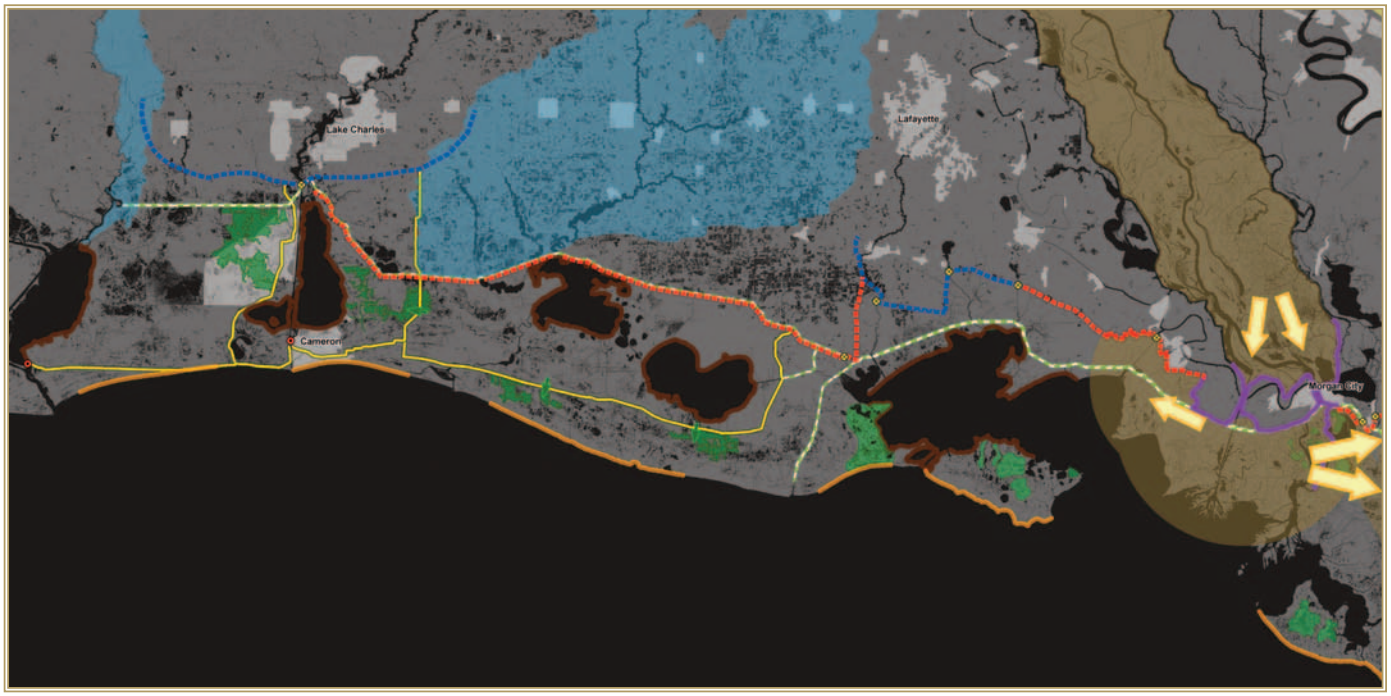


Figure 22: Hurricane protection west of the Atchafalaya River.

Atchafalaya River Diversion	- Convey Atchafalaya River Water Eastward via GIWW to Benefit Eastern and Lower Terrebonne Marshes - Convey Atchafalaya River Water Westward via GIWW - Freshwater Introduction into Central and Lower Terrebonne Marshes - Increase Sediment Transport Down Wax Lake Outlet - Optimize Flow Distribution at Old River Control Structure
Water Management Area	- Chenier Plain Freshwater and Sediment Managment and Reallocation - Mermentau Basin Watershed Management Plan to Retain Freshwater Resources - Sabine Basin Watershed Managment
Salinity Control Structure	- Salinity Control Structure at Calcasieu Pass - Salinity Control Structure at Sabine Pass
Drainage Improvements	- Hydrologic Improvements in Mermentau Basin at Highways 82 and 27
Barrier Shoreline Restoration	- Barrier Shoreline Restoration: Point au Fer Island - Barrier Shoreline Restoration: Freshwater Bayou to South Point/Marsh Island - Barrier Shoreline Restoration: Sabine River to Calcasieu River - Barrier Shoreline Restoration: Calcasieu River to Freshwater Bayou
Marsh Restoration using Dredged Material	- Marsh Restoration using Dredged Material at Point au Fer - Marsh Restoration using Dredged Material at Marsh Island - Marsh Restoration using Dredged Material at Weeks Bay - Raynie Marsh Restoration - Marsh Restoration using Dredged Material South of Highway 82 - Beneficial Uses of Dredged Material from Calcasieu Ship Channel - Beneficial Use of Dredged Material
Shoreline Stabilization in Strategic Areas	- Southwest Pass Shoreline Stabilization - Stabilize Shoreline of Vermilion, East and West Cote Blanche Bays - Stabilize Grand Lake Shoreline - Stabilize White Lake Shoreline - Stabilize Calcasieu Lake Shoreline - Stabilize Sabine Lake Shoreline
Navigable Waterway Stabilization	- Bankline Stabilization of Freshwater Bayou from Belle Isle Bayou to Freshwater Bayou Canal Lock - Fortify Spoil Banks of GIWW and Freshwater Bayou - Bankline Protection for Gulf Intracoastal Waterway (GIWW) - Bankline Stabilization of Freshwater Bayou - Fortify Spoil Banks of GIWW and Freshwater Bayou
Raise/Maintain Evacuation Routes	-Raise/Maintain Evacuation Routes Located Outside Hurricane Protection Systems - Raise and Maintain Highways 82 and 27
Structural Hurricane Protection 100 Year Protection Representative Alignment to Increase Protection to Targeted Levels Greater Than 100 Year Protection Existing/Authorized Protection	- Maintain Existing Levee Protection for Morgan City and Berwick - Wax Lake Outlet to New Iberia Hurricane Protection - Abbeville to Lake Charles Hurricane Protection - Lafayette and Vicinity Hurricane Protection - Lake Charles and Vicinity Hurricane Protection
Flood Gate	- Navigation Feature Associated with Hurricane Protection Structures

Raising Highways in the Chenier Plain: Issues to Consider

What does the project accomplish? It would reduce surge impacts in the Mermentau Basin and provide an enhanced level of protection for southwest Louisiana communities.

What are the issues involved? Some residents of southwest Louisiana are concerned that the state is planning to raise and widen Highway 82 along its entire length in the Chenier Plain. In so doing, residents worry, the state will expropriate privately owned homes and land, forcing relocation of whole communities. Raised highways may also exacerbate drainage problems should storm surge overtop them.

How can the issues be addressed? If the highway is located on a chenier, the road is already on a landscape feature at or above the targeted elevation, and raising it further is unnecessary. Thus, the plan does not recommend raising the highway on cheniers. Instead, the plan recommends improving protection to homes and properties located on cheniers by armoring highway embankments in certain vulnerable locations. This will ensure that the road can be used safely after storms. In selected low spots, such as south of White Lake or along the eastern edge of Highway 82 south of Forked Island, the highway will need to be raised in order to protect the Mermentau Freshwater Basin. However, there are few human settlements in such areas, and impacts on landowners are expected to be minimal. Structures will be built into the raised highways to improve drainage.

What happens if we maintain the status quo? Storm surge will continue to encroach into marshes and southwest Louisiana communities, endangering fresh water supplies.

Hurricane Protection in the Chenier Plain: Issues to Consider

What does the project accomplish? Building targeted barrier shoreline restoration projects, including offshore segmented breakwaters, and raising and fortifying selected portions of LA Highways 82 and 27 (see above) will provide first and second lines of defense against storm surge for communities such as Cameron, Holly Beach, and Pecan Island. Communities further inland will have more protection based on the concentration of assets at risk.

What are the issues involved? Shoreline communities south of the GIWW will not have levee protection under this proposed plan.

How can the issues be addressed? Citizens who live in this area will need to meet certain building code and height requirements in order to obtain insurance.

What happens if we keep the status quo? Major metropolitan areas and strategic oil and gas infrastructure will remain at unacceptable risk from storm surge.

Chapter 4: Master Plan Implementation
A Plan for Delivering Results

Assumptions Driving Master Plan Implementation

1. Work cannot begin on every project at once. Plan elements must be prioritized.

2. Funding constraints, institutional barriers, and technical unknowns will influence which measures can be implemented first.

3. Upon approval of the Master Plan, the state's Annual Plan, a separate document, will present project priorities, scheduling, and cost information.

4. Projects presented in the Annual Plan must balance the four coast-wide objectives.

Working within constraints. The planning team identified the measures described in Chapter 3 using the working assumptions that each measure was critically important and would be implemented as soon as possible to achieve the objectives of the Master Plan. However, building and maintaining these measures will cost tens of billions of dollars. As a matter of practicality, therefore, it is not feasible for all of the measures in the Master Plan to be constructed at the same time.

In order to take the process to the next level, the following constraints must be considered:

- Funding, materials, and other resources are limited and will restrict both what can be done and how quickly projects can be completed. Certain projects must be constructed before others in order to achieve intended outcomes.
- Some existing laws, policies, and other administrative procedures must be updated if the Master Plan is to be implemented as envisioned.
- Several concepts require further planning before they can be designed or constructed.
- Some of the proposed projects will take many years to plan, design, and construct.

While recognizing the limitations that these constraints impose, the state cannot wait until these challenges are resolved before it begins planning, designing, and constructing projects. The state will proceed on the strong foundation built through years of protection and restoration work while leaving room to adapt the plan as conditions change and lessons are learned.

As the program evolves, the state will regularly review the need to add new projects, delete certain projects, and change the location, size, or capacities of other projects.

The state's *Annual Plan: Ecosystem Restoration and Hurricane Protection in Coastal Louisiana* is published each spring before the state's legislative session begins. As its name implies, the Annual Plan must identify hurricane protection and coastal restoration projects, as well as other actions, which will be undertaken in that fiscal year. Cost estimates for actions to be taken are provided in the Annual Plan as well. The state is also expanding the format of the Annual Plan to include a "report card" of progress made and a forecasted sequence of project priorities for up to three years. Of course, such forecasts are not written in stone. If conditions on the ground change, if funding levels change, or if technical issues are resolved more quickly than anticipated, then project schedules will be modified. This use of the Annual Plan will allow the state to present what it plans to achieve in the near-term without scheduling action steps so far in advance that the quality of the assumptions used would be questionable.

The Annual Plan will outline the actions that will be undertaken in the next fiscal year to protect and restore communities and natural resources. Other projects listed in the Annual Plan will advance the knowledge needed to make progress over time. In this way, the plan will seek to deliver results while also laying the groundwork for new measures. When the state assesses how the overall coastal protection and restoration program can best be adapted to changing conditions and new information gained, it will include this information in the next Annual Plan. In this way, the plan will offer yearly updates on progress, strategies, technical challenges, and priorities.

Courtesy Scott Russell Photography

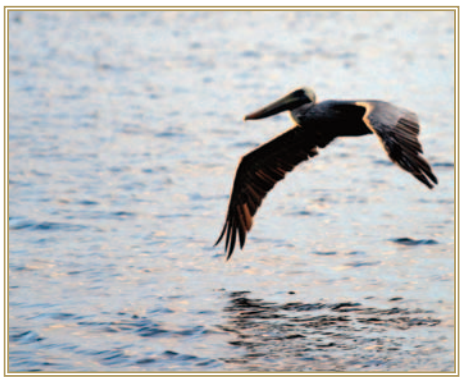
Flock of white pelicans in St. Bernard Parish marshes.

The Annual Plan's provisions, in aggregate and over time, must achieve the four coast-wide objectives that have guided work on the Master Plan (see Chapter 3 for full text of objectives). Each of these objectives —reduce risk to economic resources, restore sustainability to the coastal ecosystem, maintain a diverse array of fish and wildlife habitat, sustain heritage and culture—is integral to the continued vitality of south Louisiana.

Selecting the Annual Plan's projects. The first step is to identify which activities must move forward on a faster track—the so-called "Urgent Early Actions." Although this term implies a focus on emergency measures only, "Urgent Early Actions" include any measure that aggressively pursues high priority activities, regardless of how long it will take to plan, design, or construct. Measures selected for inclusion in the Annual Plan as Urgent Early Actions must meet at least one of six criteria. These criteria reflect the need to build projects now while also laying the groundwork for large-scale, conceptual measures. The criteria are listed below.

- Measures that will reduce key uncertainties and thereby help speed the construction of other projects described in the Master Plan. Mississippi River Delta Management could be seen as such a measure, because it will illuminate options for constructing major diversions. These diversions will, in turn, support the long-term sustainability of wetlands surrounding the Mississippi River while also maintaining navigation and other vital economic activities in the region.

- Projects that do not involve major new construction but are simply modifications of existing structures' operations. Modifying the ways that the Davis Pond and Caernarvon Diversion projects operate could be seen as Urgent Early Actions under this criterion, because the projects will have relatively low costs compared to the ecosystem benefits that can be derived. We may need changes in federal laws to authorize these kinds of changes.



Courtesy Scott Russell Photography

Brown pelican over lake in South Louisiana.

- Projects that protect concentrated and strategic assets that were identified in the Master Plan as needing a greater than 100 year level of protection, meaning protection over the level needed to withstand a storm that has a 1% chance of occurring in any given year. Beginning planning and design of the Lake Pontchartrain Barrier Plan to increase the effectiveness of New Orleans's hurricane protection system could be identified as an Urgent Early Action under this criterion.

- Projects that maintain or reestablish a landscape feature that is a linchpin for restoring or sustaining the flow of water in a given area. The closure of the MRGO at Bayou La Loutre as well as barrier island restoration could be seen as Urgent Early Actions under this criterion.

- Projects that restore natural processes in an area of high projected land loss. The proposed Mississippi River diversions in the Master Plan would allow river water and sediment to sustain basin wetlands. Such diversions could be included as Urgent Early Actions under this criterion.

- Projects that sustain processes that are key to the social and economic viability of an existing community. Projects such as the Mississippi River Diversion at Bayou Lafourche could be considered Urgent Early Actions under this criterion.

It is also necessary to consider the remaining measures in the Master Plan to determine which are essential to the success of the Urgent Early Actions. For example, the MRGO/Lake Borgne land bridge must be maintained if the Violet Diversion is to be viable. A list of such supporting measures for each Urgent Early Action will be compiled.

The next step involves sorting the list of Urgent Early Actions and their supporting measures into one of the following categories:

- Planning: the concept is currently being evaluated or needs to be evaluated before engineering and design can begin.

- Engineering and Design: planning is complete, and the measure was found to be feasible. The project is either ready to be designed, or engineering and design are already underway.

- Awaiting Construction: planning and design of the measure is complete; the project is awaiting or has received authorization, and construction is ready to begin.

- Modification: the measure has already been built and requires modifications either to the structure or to its operations.

Understanding the implementation status of each Urgent Early Action can help clarify certainties about the projects' viabilities, potential costs, and schedules.

Together, the selection of Urgent Early Actions, the identification of supporting measures, and the definition of each action's status provide the basis for deciding which new projects to begin in any given year. For a more detailed description of how these decisions are being made, see Chapter 5 in Appendix A of the Master Plan. See Chapter 3 of the Fiscal Year 2008 (FY 08) Annual Plan for discussion of the Urgent Early Actions. All appendices and the FY 08 Annual Plan are available at www.louisianacoastalplanning.org.

Adaptive Management

Chapter 3 and Appendix A of the Master Plan provide a list of projects and promising concepts that are expected to meet the plan's coast-wide objectives. However, putting these measures into practice may require decades. Meanwhile, changes in social, political, and environmental conditions will influence the contents of the plan as well as how the plan is implemented. In addition, science and engineering will continue to improve as the coastal protection and restoration program moves forward. Given the dynamic nature of the coast, the degree to which human communities are entwined with the natural system, and the rapid pace of advancements in science and technology, the coastal protection and restoration program must be managed in a way that allows for adaptation. Learning from action taken and making improvements based on knowledge gained will keep the plan relevant into the future.

An adaptive management strategy is crucial for making sure that the program remains true to its basic objectives while also integrating valuable new information and allowing necessary shifts in priorities. By using a science and performance based process for assessing how the plan and its projects need to change over time, we can ensure that the best available practices are consistently used. The use of adaptive management also presupposes strong engagement from citizens and other affected constituencies. This includes enhanced dialogue with a range of stakeholders, including landowners, fishers, and the navigation community, as well as scientific, engineering, and other technical experts.

Adaptive management acknowledges that we cannot predict with absolute certainty what will happen as we undertake to change a large and complicated natural system, that understanding these complexities requires experts and stakeholders from many disciplines, and that we must continually monitor and assess the results of our actions in order to make sure that we are learning from experience. Adaptive management is thus a way to use science and public participation to resolve the challenges described in Chapter 2 as expeditiously and fairly as possible.

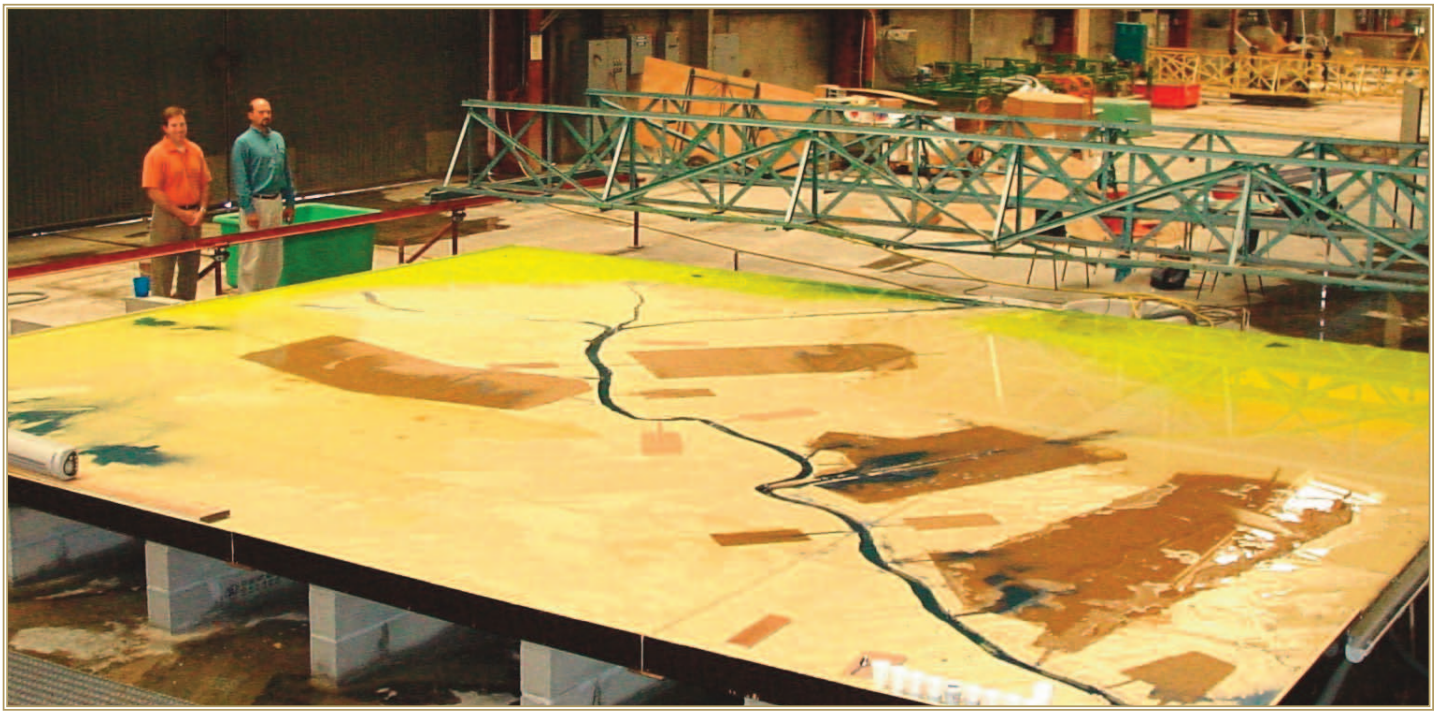
One crucial area that the state's adaptive management program must investigate is how storm risks will change over time. Following the lead of the Dutch, the state will take a two-pronged approach: (1) examine how storm trends are changing, and update our understanding of how frequently a surge of a given height will occur; and (2) investigate the condition of our flood control structures, and if flaws are found, retrofit all related structures to be sure the problem is corrected throughout the entire levee system. These reassessments should be conducted regularly to keep up with ongoing changes in modeling results, improved data collection, and shifts in environmental conditions due to climate change and other factors. Such reassessments will help the state tailor its responses to the actual risk. The adaptive management approach envisioned for Louisiana's coastal restoration and hurricane protection program will affect all levels of activity, from the establishment of overall priorities, to policy and legislation, to research initiatives, to project construction, and the development of tools for accomplishing specific tasks.

Reducing Scientific and Technical Uncertainties

To support this adaptive management strategy, the Master Plan identifies actions that will help address scientific uncertainties, promote technical advancements, and improve the data used at all levels of decision making. The state has been and will continue to pursue all of these objectives.

Improve and expand modeling capabilities. Models are among the state's primary planning and design tools for evaluating protection and restoration options. Good models help assess the potential effects of projects, uncover potentially hidden consequences, and allow relatively rapid comparison of alternative concepts so that the most effective projects can be built more quickly. For example, modeling can provide insight into the different effects of a 5,000 cfs diversion versus a 15,000 cfs diversion; one may build land more quickly but cause more drastic shifts in habitat. Up-front analysis of these tradeoffs allows planners and the public to make more informed decisions. In addition, models help evaluate how high levees must be to provide targeted levels of protection. These results allow planners to identify and correct potential problems with projects at the design stage, thereby saving both time and money. Lastly, models project the paths and strengths of oncoming storms, which can allow the timely activation of evacuation and emergency response plans. Given the importance of modeling to the overall coastal protection and restoration program, the state must improve the scope and quality of these capabilities.

Conceptual models. A conceptual model is a visual or narrative summary that describes the important components of a system and the interactions among them. Establishing the basic assumptions behind system function is the goal of conceptual modeling. These assumptions must be reevaluated regularly, since conceptual models are often the basis for analytical modeling.



The state's small scale physical model shows potential effects of a land building diversion scenario. Blue indicates sediment deposition and land gain over a simulated 100 year period.

Physical models. Physical models are tangible representations of hydrologic processes in a given area. As such, the models can provide insights into how the system functions overall. Louisiana has a small-scale physical model of a portion of the Mississippi River's Deltaic Plain. The model has helped researchers better understand how major river diversions proposed for the area would spur land building.

Photo of analytical model output , CLEAR model

Analytical models. Analytical models use the functional relationships described in conceptual models to predict a system's response to specific measures or combinations of projects. A variety of powerful analytical models have been used to prepare the Master Plan. However, these models must be continually improved in order to support the Master Plan's integrated mission.

For example, storm surge models predict how storm waters may move inland. In order for this capability to more accurately reflect the conditions in play, storm surge models need to better quantify how barrier islands, marshes, coastal forests, ridges, and other landscape features interact with storm surges. Improvements also need to be made to ecosystem response models such as the Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) model. Finally, we need improved socioeconomic models that link human and economic value to biological and physical processes. These models have not been developed to the same degree as other analytical models. This deficiency must be addressed if the state is to have all the tools needed to fully evaluate management decisions against the four Master Plan objectives.

Support a strong data collection and information management program. Models are only as good as the data and assumptions used to calibrate them. To make sure that all data and assumptions are of the highest possible quality, the following actions are recommended.

Improve collection and management of basic data. The Louisiana coast is changing so rapidly that some information about it quickly becomes outdated. The state needs a system for acquiring and regularly updating data about landscape characteristics such as: how high the land is, how deep the inland and offshore waters are, and the net effect of sea level rise coupled with subsidence. We also need improved data about the coast's human and natural communities, such as population totals and economic inventories, as well as habitat distributions and fisheries dynamics. Much of this information is being collected, but it needs to be catalogued and made more accessible so that it can be incorporated into models.

Complete a regional sediment inventory. We need to know how much sand and sediment are available for restoration and protection projects. To meet this need, an inventory of available sediment in riverine, navigation channel, and offshore sources should be completed. Compiling existing sediment related data is another important step, as is developing a regional sediment budget model that would identify sources of renewable sediment. As part of this effort, the state should refine its understanding of the availability, particle size, accretion and consolidation rates, and other characteristics of sediments that could be used for restoration and protection projects.

CRMS program collects data about wetland change using a network of sites that evaluate the combined effects of individual projects on the ecosystem.

Expand the Coast-wide Reference Monitoring System. In recent years, the state and its federal partners have begun a new ecosystem monitoring program called the Coast-wide Reference Monitoring System (CRMS)-Wetlands. The program collects data about wetland change using a network of sites that evaluate the combined effects of individual projects on the ecosystem. As the expanded CRMS and its sister program for barrier islands and shorelines, the Barrier Island Comprehensive Monitoring Program, continue to gather data over the next several years, the state will be able to discern natural ecosystem variability from the effects of restoration and protection projects. Such information will allow the state to more fully assess the Master Plan's performance. Data collected through coast-wide monitoring will also be used to improve the quality of models. To complete the suite of baseline data being collected in coastal Louisiana, the Master Plan recommends that this program add a component to assess conditions in coastal waters.

Support focused research and demonstration projects. Research and demonstration projects offer the opportunity to test new concepts on a small scale, with relatively small investments of time, money, and materials. The results of demonstration projects can reduce the unknowns associated with cutting edge concepts, thereby helping the state focus its resources wisely. Examples of topics needing focused research and/or demonstration projects include an investigation of how climate change could affect Louisiana, and research to improve our understanding of how wetlands and other coastal features affect storm surge and wave patterns. Other projects could help define guidelines for using pipeline delivery of sediments to create sustainable marsh, as well as technologies that may build stronger hurricane protection structures than traditional methods allow.


LOUISIANA
COASTAL PROTECTION & RESTORATION AUTHORITY
INTEGRATED PLANNING TEAM

September 2006
Volume 3

IPT Solicits Comments from Stakeholders

Starting in mid-August, the Coastal Protection and Restoration Authority's Integrated Planning Team (the IPT) began meeting with stakeholder groups informing them of the methodology and process by which the Louisiana Coastal Protection Master Plan is being prepared. The objective of these meetings has been to provide information to stakeholders and to receive direct input.

By mid-September, presentations had been made to the following groups: Parishes Against Coastal Erosion (PACE), floodplain managers, regional planning districts, environmental interest groups, and the parishes of Calcasieu, St. Mary, and Vermilion. The IPT has also made presentations as guests at the board meetings of the Louisiana Landowners Association, ten levee boards, and at the Barataria-Terrebonne National Estuary Program Management Conference.

The IPT requires that feedback from these and other stakeholders is addressed and incorporated into the planning process. Inquiries and input from stakeholders will be received, reviewed, and assessed continuously as part of the planning process throughout the project analysis phase of plan preparation prior to publication of the draft in November 2007.

Issues brought up by stakeholders during meetings to date have reflected concerns ranging from future development in the coastal region to levee alignment. Attendees offered a number of recommendations for consideration by the IPT team related to maximizing marsh restoration, restoring marsh using all sediment sources especially those from the Mississippi and Atchafalaya Rivers, and using non-structural restoration in combination with linear and ring levees. Several comments suggested maximum protection including structural solutions across all of Louisiana's

Presentation at the Calcasieu Parish Police Jury Committee Meeting in Lake Charles, LA


LOUISIANA
COASTAL PROTECTION & RESTORATION AUTHORITY
INTEGRATED PLANNING TEAM

November 2006
Volume 4

IPT Interagency/SERT Alternative Plans Review Workshop

On October 24 and 25th, 2006, the Integrated Planning Team (IPT) hosted an interagency workshop. Approximately 38 technical experts, including the Science and Engineering Review Team (SERT) gathered to assist the IPT in evaluating technical analyses, stakeholder comments, and addressing unresolved issues associated with the two alternative plans. Included were representatives from federal, state, and local agencies, parishes, levee districts, universities, and specialized nongovernmental organizations (NGOs). Through workshop discussions, the participants sought to define specific areas lacking consensus and to aid in IPT formulation of the Preliminary Draft Master Plan.

In the workshop introduction, the IPT outlined the meeting goals and described the decision making process, objectives of the program, and review materials used in alternative plan analysis and scoring. Attendees divided into working groups based on five coastal planning units described in the plan. During these breakout sessions, one room was devoted to the Deltaic Plain (planning units 1, 2, and 3a), while the second focused on the Chenier Plain (planning units 3b and 4). Each group was tasked with assessing results of alternative plan analysis and beginning to outline the preliminary draft Louisiana Comprehensive Coastal Preliminary Master Plan.

Overall, the groups sought outcomes that best balance the following four planning objectives:

1) Reduce economic losses from storm based flooding
2) Promote a sustainable coastal ecosystem
3) Provide habitats suitable to support an array of commercial and recreational activities countwide
4) Sustain, to the extent practicable, the unique cultural heritage of coastal Louisiana.

At the end of the workshop, each group presented its proposals for protection and restoration of the coastal areas in the respective regions. These determinations were used as inputs for further analysis at the ITT Plan Refinement workshop held October 31st.

IPT Interagency/SERT Alternative Plan Review Workshop


LOUISIANA
COASTAL PROTECTION & RESTORATION AUTHORITY
INTEGRATED PLANNING TEAM

January 2007
Volume 5

Preliminary Draft Plan Goes Public

On November 29 and 30, 2006, the Coastal Protection and Restoration Authority (CPRA) released a preliminary draft of the Louisiana's Comprehensive Coastal Protection Master Plan. The draft plan was made available to the public on the internet and at presentations held in New Orleans, Houma, and Lake Charles. Local officials, residents, and other stakeholders gathered to review and comment on the state's first plan to restore and protect the coast. The draft plan can be downloaded from louisianacoastalplanning.org, the website of the CPRA-Integrated Planning Team (CPRA-IPT).

Besides releasing the preliminary draft of the comprehensive master plan, the meeting also provided an opportunity for the CPRA to listen to comments and concerns from the public. Members of the Authority, including the Steering Committee, attended each meeting to answer questions and accept public comment. Public officials, stakeholders, and interested Louisiana residents gathered to review and comment on the plan.

CPRA-IPT members stressed that the Comprehensive Coastal Protection Master Plan for Louisiana Preliminary Draft is still conceptual and not yet a complete plan as comments and statements from the public must be evaluated and, where appropriate, incorporated into the plan. The preliminary draft and its appendices describe (a) the planning process used in the plan's development, (b) the plan objectives used in determining alignments and other plan features, (c) public comments from earlier stakeholder meetings, and (d) an outline of the steps necessary for plan implementation and maintenance. Yet to be incorporated in the plan are the priority, sequence, and costs of the plan's individual projects. Comments received during the public comment period, from the end of November until January 5, 2007, will assist the CPRA-IPT in developing the sequence of projects to be included in the final draft plan due to be released in February 2007.

Attendees line up to offer comments to members of the CPRA board in Houma

Improve the tools available for assessing the program. To be effective, the program must constantly assess the quality of what it has accomplished. In this regard, every project constructed should include "as built" designs as part of the contractor deliverable. Design, operations and maintenance, and assessment protocol manuals should also be developed to maintain institutional knowledge. Incorporation of peer reviewed comments from both technical and public stakeholders is another measure that managers must employ to improve the technical quality and scope of management decisions. Using these tools, a regular report on progress made should be developed. This report will allow managers, stakeholders, and the public to understand what has been accomplished. These reviewers can then suggest timely adjustments to projects and the Master Plan.

Expand efforts to engage stakeholders and the public. Establishing an effective and on-going stakeholder and public communication strategy is an essential part of implementing the Master Plan. Citizens provide important ideas about what has already been done, and they can help planners avoid future problems by voicing concerns about trends and impacts in their communities. Dialogue among scientists, engineers, planners, and the public also helps ensure that everyone clearly understands which options are technically feasible.

In formulating this first *Comprehensive Master Plan for a Sustainable Coast,* the planning team held more than 50 stakeholder, science and engineering, and public meetings. The information gained at these meetings helped shape both the overall scope and the detailed discussions in the Master Plan (see Chapter 3). As implementation and refinement of the plan continues, this level of interaction with the public and stakeholders must continue, and even increase, to ensure long-term success. The plan recommends expanding outreach to the public and the media so that the urgent needs of our coast are well communicated in print, radio, and TV coverage. The Interdisciplinary Technical Team should continue to be involved so that information about changing public needs as well as advances in science and engineering can be more easily shared.

Removing Institutional Constraints

Protecting and restoring the coast is not just a matter of building large-scale, high profile projects. Institutional challenges to progress must also be resolved to avoid costly delays and ensure that all projects deliver maximal benefits.

Increase awareness and use of non-structural protection measures. The state must encourage citizens and local governments to take greater advantage of the many non-structural measures available for reducing risk from storm surge. Such measures can help residents and businesses make their homes safer while also reducing flood insurance premiums.

- *Mandatory disclosure laws*. Require that purchasers be notified if their future properties are located in either a 100 year or a 500 year floodplain. This notification should be made before financing for the purchase is approved.

- *Floodplain management training.* Require mandatory training in floodplain regulations for certified building officials responsible for enforcing the new statewide building codes. The training would help these officials be informed about flood elevation requirements as they conduct their day to day responsibilities as inspectors. Such training should also be extended to real estate agents and lenders.

- *Begin a statewide education/outreach campaign.* The campaign's goal should be to inform citizens about the Community Rating System and the many ways in which citizens can reduce their flood insurance premiums. This campaign should be conducted by professional media consultants and use public service and/or paid announcements on television, radio, and print media.

Improve land use planning, zoning, and permitting. During the planning and public comment periods for this document, several people expressed the concern that constructing new hurricane protection systems must not encourage unwise development into high risk areas. Indeed, development has expanded into low-lying areas in the past, serving to increase overall levels of risk and diminishing the effectiveness of the protection structures themselves. Such an outcome would be counter to the Master Plan's objectives of sustaining wetland ecosystems and reducing the flooding risks borne by coastal communities.

Appropriate land use planning and zoning can help achieve these objectives. To this end, the Louisiana Coastal Resources Program and the Louisiana Coastal Zone Management Plan should be strengthened. Zoning actions by local governments, though not popular in Louisiana, are another means of protecting coastal wetlands. State legislation as well as departmental policies should provide incentives that spur local governing bodies to enact region-wide land use zoning. These efforts could follow the lead of Lafayette, Louisiana which has already made great strides in land use planning.

The Louisiana Sea Grant Program and the Coalition to Restore Coastal Louisiana are working on a review of land use planning tools in Louisiana. Their objectives are: to assess state land use planning authority and practices, to provide planners with information on legal and policy tools, to identify gaps in planning authority, to provide information on planner needs to lawmakers, and to facilitate better planning for public safety in the coastal zone. The Coastal Protection and Restoration Authority will convene a working group, including members of parish governments, legislators, landowners, and agency personnel, to examine this report and develop a strategy for implementing required actions. This strategy will guide smart growth that is consistent with the objectives of the Master Plan.

Address processes to acquire land rights. Approximately 80% of coastal Louisiana is privately owned, and the rights of these landowners, including mineral rights, must be honored as components of the Master Plan are constructed and operated. Through many years of working on projects in coastal Louisiana, the state Departments of Natural Resources (DNR) and Transportation and Development (DOTD) have built strong working relationships with most of the coast's major landowners. In order to complete the Master Plan's measures in a timely fashion, these relationships must be fostered and strengthened.

Land ownership has many faces in coastal Louisiana. Often, large tracts of land are owned by a single entity. In other cases, single parcels of property may be owned by hundreds of individuals that are either difficult to contact or, in some cases, unknown. This is particularly true when land has been passed down through generations. Situations will also arise in which multiple parcels of land are needed to implement very large projects. If many parcels of land are needed for a given project, or if the state needs a parcel of land for a project but the parcel is owned by multiple parties, a single landowner's desire not to participate can delay or even terminate the project.

Multiple options must be available to reach equitable solutions for building projects on private lands. The simplest option is to acquire the necessary easements to construct the project. Another option would be to allow for separation of surface rights from mineral rights. The state could then purchase the surface rights to the land, while the original landowner would retain all subsurface and mineral rights.

In cases where such an agreement cannot be reached on a project that is in the best interest of the public, expropriation is a possibility. Both DNR and DOTD can expropriate land under Title 19 of the Louisiana Revised Statutes. However, expropriating involves filing a lawsuit, and the lawsuit must be resolved before the project can begin. This long and contentious process is clearly not a desirable outcome.

Another choice for acquiring the necessary land rights to construct projects that are in the best interest of the public is an authority known as "quick take." When a negotiated settlement cannot be reached after good faith negotiations between the implementing agency and the landowner, and if delays in land acquisition will delay project construction, quick take authority allows the agency to place the offered compensation in the court registry and file a lawsuit against the landowner. Progress toward project construction is not hindered by that action or the suit, and whatever compensation the landowner will ultimately receive is settled at a later date. DOTD has this authority for roadway construction, and levee districts have this authority for levee projects.

To date, DNR has never entertained the idea of using either form of condemnation and considers both to be options of last resort. However, in order to ensure that large-scale projects are built on time, these options must be available, particularly in cases where property would be damaged or destroyed in order to build project features. Thus, although it is the state's clear preference to work in partnership with landowners to achieve the objectives of the Master Plan, passage of legislation to provide DNR and DOTD with "quick-take" authority for the implementation of this plan, similar to that already provided to DOTD for highways, is necessary at this juncture.

Foster the sustainability of coastal forests. Louisiana's coastal wetland forests are of tremendous economic, ecological, cultural, and recreational value to residents of Louisiana, the people of the United States, and the world. But the same stressors that are affecting coastal marshes are also degrading coastal forests and causing outright loss of this habitat.

Louisiana has had best management practices for coastal wetlands since 2000 (Louisiana Department of Agriculture and Forestry, Environmental Protection Agency, and Louisiana Department of Environmental Quality 2000). However, these practices do not address coastal forests or forested wetlands as distinct ecosystems. Governor Blanco activated a Science Working Group to provide information and guidelines on creating sustainable coastal forests, from both environmental and economic perspectives. The group's findings, including specific objectives, were compiled and submitted in a report entitled "Conservation, Protection and Utilization of Louisiana's Coastal Wetland Forests" (Coastal Wetland Forest Conservation and Use Science Working Group, 2005, www.coastalforestswg.lsu.edu).

The group then recommended that its function be split; the Science Working Group itself would deal with science questions, and a separate Advisory Panel would define stakeholder issues. The Advisory Panel would also make policy recommendations for sustainable management of coastal forests in Louisiana based upon the Science Working Group's 2005 report. The Advisory Panel consists of stakeholders, non-government organizations, and state and federal agencies.

This division of responsibility was enacted, and the Advisory Panel's recommendations were released in March 2007 (see Appendix A). The CPRA is now reviewing these recommendations in order to define the state's policies on managing coastal forests. These policies should be implemented as expeditiously as possible in order to provide for the long-term sustainability of threatened coastal forest resources.

Obtain dedicated funding sources. Louisiana cannot implement the Master Plan unless it obtains larger and more reliable funding streams. The state's Coastal Protection and Restoration Fund receives $25 million in state funds annually to address coastal protection and restoration issues, and the federal government dedicates approximately $50 million per year through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Program. Funding for hurricane protection projects and other coastal restoration activities comes through annual federal and state appropriations processes, and as such, the dollars allocated are determined by fluctuating fiscal priorities. As a whole, this level of funding is less than what will be required to build the projects presented in the Master Plan.

The Energy Policy Act of 2005 created the Coastal Impact Assistance Program, which will provide approximately $523 million through 2010 to Louisiana and its coastal parishes. The funding is designed to support coastal restoration and infrastructure projects that mitigate the impacts of offshore oil and gas activities. The program will be an important asset as Louisiana ramps up its coastal restoration effort. However, the nation's most successful civil works programs, such as construction of the Interstate Highway System, were supported by a more stable long-term funding commitment. A similar national commitment, buttressed by strict standards of accountability, must be made in order to save Louisiana's coast.

In December 2006, the U.S. Congress passed legislation regarding the sharing of outer continental shelf revenues. This will provide the state and coastal parishes approximately $20 million per year until 2016. In subsequent years, the amount Louisiana receives will increase to between $300 and $500 million per year. Similar commitments of federal funds will need to be applied to this effort.

Address implementation challenges at the federal level. The federal government's traditional method for building hurricane protection and coastal restoration projects works well for endeavors that are localized and relatively narrow in scope. However, the coast-wide, comprehensive program presented in the Master Plan cannot be accommodated using this traditional framework.

The Congressional authorization and appropriations processes present large challenges. For example, the Water Resource Development Act is the primary vehicle used to obtain authorization for restoration projects, but as this document goes to print, Congress has not reauthorized this act in seven years. In addition, before a project can move from planning to design to construction, the Executive Branch must give its approval and Congressional action is needed. At each juncture, a project can meet with delays lasting months or even years. Such restrictions will effectively hamstring Louisiana's coastal restoration and hurricane protection program before it can deliver results.

Program Management

Create a structure to support implementation of the Master Plan. The Integrated Planning Team, which compiled this Master Plan, was created to begin coordinating the efforts of the Department of Natural Resources and the Department of Transportation and Development, as stipulated in Act 8 (see Preface). However, the Integrated Planning Team was seen as a temporary entity that would disband after the first Master Plan was completed. The state must now develop a program structure that can support implementation of the Master Plan over the coming years.

An independent working group of scientists and engineers also recognized this need in their report entitled "A New Framework for Planning the Future of Coastal Louisiana after the Hurricanes Of 2005" (Working Group for Post-Hurricane Planning for the Louisiana Coast, 2006). The Master Plan recommends adopting recommendations from this group, particularly the suggestion that a Coastal Assessment Group be made a permanent entity within the state's management structure. The Coastal Assessment Group should use the talents of scientists and other technical experts who can reach out to the international research community to supplement their understanding of specific issues. The group would be responsible for:

- reporting on progress made toward implementing the Master Plan's measures;
- making revisions to the Master Plan as laid out in the adaptive management strategy;
- preparing the *Annual Plan: Ecosystem Restoration and Hurricane Protection in Coastal Louisiana* (Annual Plan), and ensuring that the Annual Plan's contents, including the activities of the Applied Coastal Science and Engineering Program discussed below, are consistent with the priorities set out in the Master Plan;
- helping to resolve policy, legislative, and institutional issues that may hinder progress;
- fostering greater consistency between the Master Plan and activities taking place in south Louisiana that may affect coastal protection and restoration.

The Master Plan also recommends that an Applied Coastal Engineering and Science Program be established to resolve data and knowledge gaps and to facilitate scientific, engineering, and technical advancements. This program would consult with and be supported by existing programs, such as the Louisiana Coastal Area Science and Technology Program, which focuses mainly on ecological and restoration issues. By contrast, the proposed Applied Coastal Engineering and Science Program would focus on research associated with both restoration initiatives and flood protection projects.

Provide an effective structure for federal partnerships. The federal government should act quickly to develop mechanisms for focusing federal involvement in an effective, problem-solving partnership with the state. This should include a process to align the many diverse federal agency missions related to the protection and restoration of coastal Louisiana.

Ensure monitoring and inspection of the hurricane protection system. After the disastrous hurricanes of 2005, the state took steps to enhance the levee inspection program (La.RS:38:241 and 38:247). The Coastal Protection and Restoration Authority is now responsible for ensuring that hurricane protection levees are well planned, constructed, and maintained. In support of this goal, the Department of Transportation and Development (DOTD) has implemented a mandatory levee inspection program requiring that each levee district perform quarterly inspections, correct any deficiencies found, and submit detailed inspection and remediation reports. DOTD has developed a levee inspector training and certification program to supplement its long-standing training program for directors and staff of levee boards. DOTD is also planning a program to provide oversight and quality assurance inspection of all Corps of Engineers levee construction projects.

Ensure regular reviews of the Master Plan. The Master Plan is designed to be a living document that will evolve over time to reflect our improved understanding of the coast. As a result, the full Master Plan should be reviewed and updated initially after five years, and then again at regular intervals of five to ten years as conditions warrant. In addition to these regular reviews, unforeseen circumstances—such as a major hurricane or a significant change in funding for the plan—should prompt an earlier review.

Conclusion

At the heart of all of these recommendations is the recognition that coastal Louisiana connects the nation's heartland to the rest of the world, transporting agricultural and industrial commodities and meeting the nation's energy demands while at the same time supporting amazingly productive ecosystems and culturally vibrant communities.

Ensuring the sustainability of this region requires the same basic commitment from all concerned: the resolve to achieve and maintain an unprecedented level of excellence in our plans for and care of coastal Louisiana. This commitment does not seek to elevate one set of needs over another, but rather to balance the many interests—cultural, economic, and ecological—that together make America's Wetland one of the most unique and vital coastal regions in the world.

Courtesy Donn Young / Port of New Orleans

Norwegian Cruise Lines' Norwegian Sun berths at the Port of New Orleans. The Norwegian Sun was the first cruise ship to return to New Orleans following Hurricane Katrina.

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